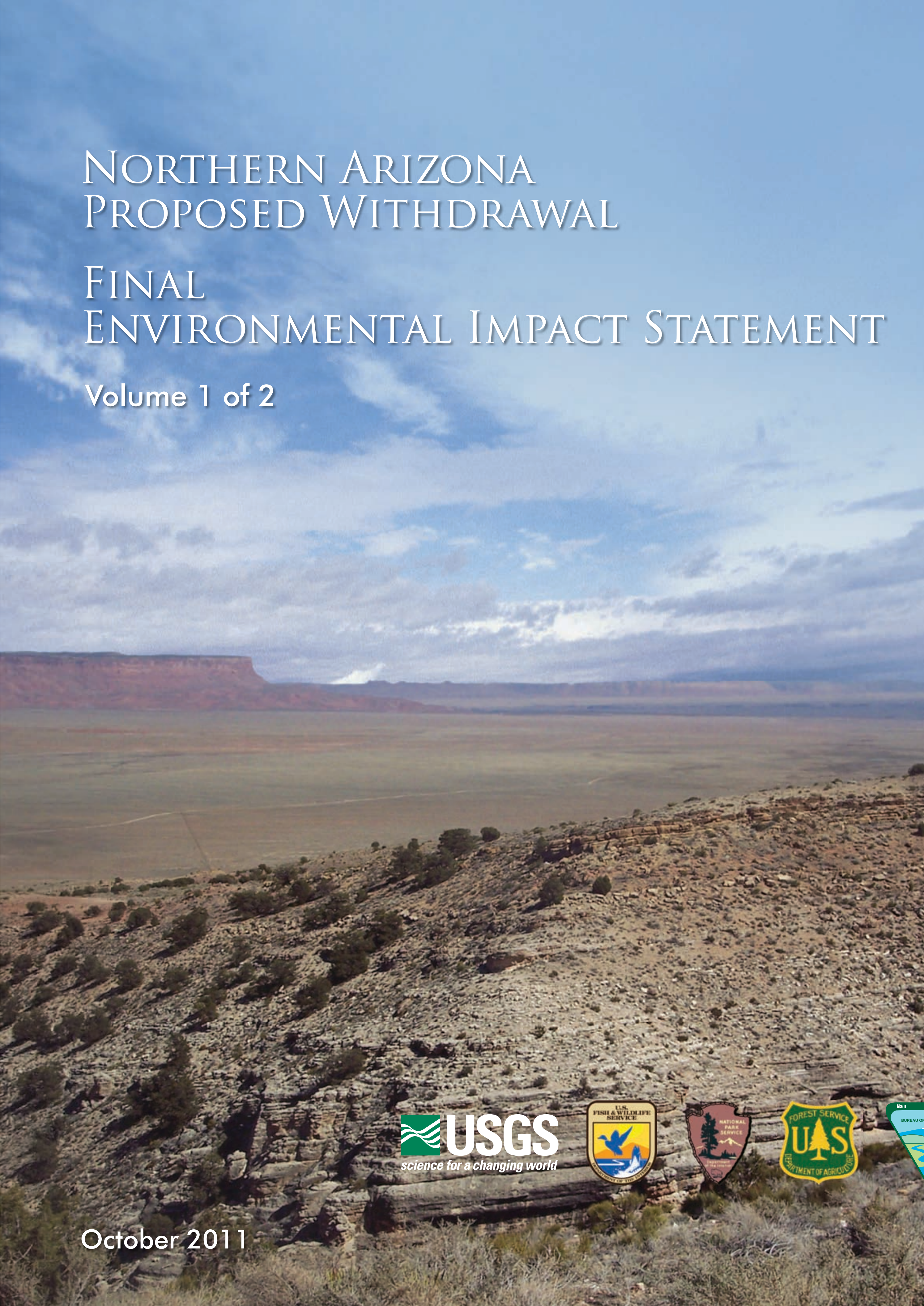
Northern Arizona Proposed Withdrawal

Final Environmental Impact Statement

Volume 1 of 2



October 2011

BLM

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MISSION STATEMENT

"The Bureau of Land Management is responsible for stewardship of our public lands. The BLM is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people. Management is based upon the principles of multiple use and sustained yield of our Nation's resources within the framework of environmental responsibility and scientific technology. These resources include recreation, rangelands, timber, minerals, watershed, fish and wildlife habitat, wilderness, air, and scenic quality, as well as scientific and cultural values."

ABSTRACT

This Final Environmental Impact Statement (EIS) documents the analysis of potential environmental impacts of the Secretary of the Interior's proposed 20-year withdrawal of approximately 1,006,545 acres of federal mineral estate in northern Arizona from the location and entry of new mining claims under the General Mining Law of 1872 [30 United States Code 22–54]. This federal mineral estate underlies approximately 626,678 of public lands managed by the Bureau of Land Management (BLM) Arizona Strip Field Office, 355,874 acres of National Forest System lands managed by the Kaibab National Forest, 4,204 acres administered by the Arizona State Land Department, and 19,789 acres of private land. The Notice of Intent to prepare this EIS was published in the Federal Register on August 26, 2009.

This Final EIS describes the physical, biological, cultural, historic, tribal, and socioeconomic resources in and around the proposed withdrawal parcels. The Final EIS considers the impacts of four alternatives, including changing the configuration and acreage of the withdrawals or not implementing the withdrawal (the "No Action" Alternative). The focus for the impact analysis was based on resource issues and concerns identified during public scoping conducted for the proposed withdrawal by BLM and other agency land managers and resource specialists. Public scoping identified concerns related to uranium exploration and development include impacts on surface and groundwater, cultural resources, air quality, wildlife, vegetation, recreation, wilderness areas, public health and safety, visual resources, and soundscapes. Other resource area concerns identified by the interdisciplinary team include tribal resources; social resources and economics; greenhouse gas emissions, ozone, and climate change; and cumulative impacts related to current uranium mining operations and other proposed development within and in the vicinity of the Grand Canyon watershed.

BLM/AZ/PL-11/002

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Arizona Strip District Office
345 East Riverside Drive
St. George, UT 84790-6714

In reply refer to:
2300(AZ9100)
AZA-035138

October, 2011

Dear Reader:

Attached is the Northern Arizona Proposed Withdrawal Final Environmental Impact Statement (FEIS) for the Bureau of Land Management (BLM) Arizona Strip District Office and the U.S Forest Service, Kaibab National Forest. The BLM prepared this document in collaboration with 15 federal, state, local, and tribal cooperators in an effort to provide an objective analysis of the Proposed Action and Alternatives based on the best available science. This FEIS has been prepared on behalf of the Secretary of Interior to inform his decision whether or not to withdraw lands in the vicinity of the Grand Canyon from the Mining Law of 1872. This FEIS was developed in accordance with the National Environmental Policy Act of 1969 (NEPA), the Federal Land Policy and Management Act of 1976, implementing regulations, the BLM's NEPA Handbook (H-1790-1), and other applicable laws and policy.

This FEIS has been prepared in response to the Secretary of the Interior's proposed 20-year withdrawal of approximately 1 million acres of federal mineral estate in northern Arizona from the location and entry of new mining claims under the General Mining Law of 1872 [30 United States Code 22–54] subject to valid existing rights, for a period up to 20 years. The proposed withdrawal area consists of approximately 1,006,545 acres of federal mineral estate, which underlies about 626,678 acres of public surface managed by the Arizona Strip Field Office, 355,874 acres of National Forest System surface managed by the Kaibab National Forest, 4,204 acres of surface administered by the Arizona State Land Department, and 19,789 acres of privately owned surface. As of July 2009, these lands were segregated for up to 2 years from location and entry of new mining claims. On June 27, 2011, the Secretary of Interior published an Emergency Withdrawal which will expire on January 20, 2012, to allow the lands to remain closed to location and entry during the completion of the NEPA process. Supporting information for this EIS is available on the project web site at: http://www.blm.gov/az/st/en/prog/mining/timeout.html.

The FEIS contains an environmental analysis of four Alternatives. Alternative A is the No Action alternative, under which there would be no withdrawal; location and recordation of mining claims would continue. Alternative B, the preferred alternative, is also the Proposed Action to withdraw 1,006,545 acres from location and entry under the General Mining Law of 1872 for 20 years, subject to valid existing rights. Alternative C is a smaller withdrawal of 650,333 acres. Alternative D is a further reduced withdrawal of 295,991 acres. A summary of changes made between the Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement (DEIS) and FEIS is included in section 1.5.4. Section 5.6 of the FEIS contains responses to public comments received on the DEIS which was released for public comment on February 18, 2011.

Upon release of the FEIS to the public, in accordance with 40 CFR 1506.10, the Secretary of interior may make a final decision after 30 days have elapsed. At such time, the Department of Interior will issue a Record of Decision (ROD). The ROD will be available to all parties through the Northern Arizona Proposed Withdrawal project page at: http://www.blm.gov/az/st/en/prog/mining/timeout.html, or by mail upon request. If the Secretary's decision includes a withdrawal, a Public Land Order will be published in the Federal Register, which will implement the Secretary's decision.

Sincerely,

Scott R Florence

Scott R Florence, Arizona Strip District Manager
Bureau of Land Management

ENVIRONMENTAL IMPACT STATEMENT
Northern Arizona Proposed Withdrawal

U.S. Department of the Interior
Bureau of Land Management
Arizona Strip District Office
St. George, Utah
October 2011

Lead Agency: U.S. Department of the Interior, Bureau of Land Management

Type of Action: ( ) Draft (X) Final

Cooperating Agencies: U.S. Forest Service; Kaibab National Forest
National Park Service; Grand Canyon National Park
U.S. Fish and Wildlife Service
U.S. Geological Survey
Arizona Game and Fish Department
Arizona Geological Survey
Arizona Department of Mines and Mineral Resources
Arizona State Land Department
Hualapai Tribe
Kaibab Band of Paiute Indians
Coconino County, Arizona
Mohave County, Arizona
Garfield County, Utah
Kane County, Utah
San Juan County, Utah
Washington County, Utah

Responsible Official: The Honorable Ken Salazar, Secretary of the Interior

For Further Information Contact: Scott Florence
District Manager
BLM Arizona Strip District
(435) 688-3200

Abstract

This Final Environmental Impact Statement (EIS) documents the analysis of potential environmental impacts of the Secretary of the Interior's proposed 20-year withdrawal of approximately 1,006,545 acres of federal mineral estate in northern Arizona from the location and entry of new mining claims under the General Mining Law of 1872 [30 United States Code 22–54]. This federal mineral estate underlies approximately 626,678 of public lands managed by the Bureau of Land Management (BLM) Arizona Strip Field Office, 355,874 acres of National Forest System lands managed by the Kaibab National Forest, 4,204 acres administered by the Arizona State Land Department, and 19,789 acres of private land. The Notice of Intent to prepare this EIS was published in the *Federal Register* on August 26, 2009.

This Final EIS describes the physical, biological, cultural, historic, tribal, and socioeconomic resources in and around the proposed withdrawal parcels. The Final EIS considers the impacts of four alternatives, including changing the configuration and acreage of the withdrawals or not implementing the withdrawal (the "No Action" Alternative). The focus for the impact analysis was based on resource issues and concerns identified during public scoping conducted for the proposed withdrawal by BLM and other agency land managers and resource specialists. Public scoping identified concerns related to uranium exploration and development include impacts on surface and groundwater, cultural resources, air quality, wildlife, vegetation, recreation, wilderness areas, public health and safety, visual resources, and soundscapes. Other resource area concerns identified by the interdisciplinary team include tribal resources; social resources and economics; greenhouse gas emissions, ozone, and climate change; and cumulative impacts related to current uranium mining operations and other proposed development within and in the vicinity of the Grand Canyon watershed.

EXECUTIVE SUMMARY

INTRODUCTION

On July 21, 2009, the Department of the Interior published notice of the Secretary of the Interior (Secretary) Ken Salazar's proposal to withdraw (proposed withdrawal) approximately 1 million acres of federal locatable minerals in northern Arizona from the location of new mining claims under the Mining Law of 1872 [30 United States Code (USC) 22–54] (Mining Law), subject to valid existing rights. The withdrawal was proposed in response to increased mining interest in the region's uranium deposits, as reflected in the recent increase in the number of new mining claim locations, and concern over potential impacts of uranium mining on the Grand Canyon watershed, adjacent to and including Grand Canyon National Park (the Park).

The Northern Arizona Proposed Withdrawal Environmental Impact Statement (EIS) is being prepared to provide guidance to the Secretary in deciding upon this withdrawal. This document represents many months of concerted efforts on the part of experts, specialists, and representatives of the Bureau of Land Management (BLM) Arizona State Office, Arizona Strip District Office and Arizona Strip Field Office; Kaibab National Forest; Grand Canyon National Park; and multiple other federal, tribal, state, and local agencies. Any of the action alternatives outlined in the tables that follow, as a distillation of the combined thought, effort, and research from all those involved, will enable the Secretary to decide the appropriateness of withdrawal to protect the Grand Canyon watershed from possible adverse effects of locatable mineral exploration and development.

The Secretary has proposed for withdrawal approximately 1,006,545 acres of federal mineral estate, in three separate parcels, from entry under the Mining Law. The three proposed withdrawal parcels are each rich in natural and cultural resources and are intricately connected to the watershed of the Grand Canyon. The North Parcel comprises approximately 549,995 acres, the South Parcel approximately 134,454 acres, and the East Parcel approximately 322,096. Approximately 27,775 acres of non-federal surface lands are located within these three parcels. The proposed withdrawal would apply only to public domain federal mineral estate, including federal mineral estate underlying non-federal surface lands. It would not apply to non-federal mineral estate or to leasable or salable minerals (e.g., oil and gas leasing, sand and gravel permits), which are not subject to appropriation under the Mining Law. The proposed withdrawal is subject to valid existing rights that are determined to exist on those mining claims located prior to July 21, 2009, the date the lands were proposed for withdrawal and segregated from location and entry under the Mining Law by the publication of the Secretary's notice in the *Federal Register*.

PURPOSE AND NEED

The purpose of the proposed action is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur within the three areas proposed for withdrawal. The analysis presented in this EIS will provide guidance to the Secretary in deciding upon this proposed withdrawal of approximately 1,006,545 acres near Grand Canyon National Park from location and entry under the Mining Law for 20 years.

The need for the proposed action is to respond to a concern that recent increase in the number and extent of mining claims in the area could, if more are developed, have adverse effects on resources within the human environment, similar to the lasting impacts of some of the historical hardrock mining activities in the Grand Canyon watershed.

PUBLIC ISSUES AND MANAGEMENT CONCERNS IDENTIFIED DURING SCOPING

The most important step in the process of developing this EIS has been the identification of relevant issues of concern. An issue is defined as an opportunity, conflict, or problem regarding the use or management of federally managed lands. The formal public scoping process began on August 26, 2009, with the *Federal Register* publication of the Notice of Intent to prepare an EIS for a proposed withdrawal. By the end of the formal scoping period, the BLM had received a total of 83,525 comment submittals. All comments received for this scoping effort were assigned, based on content, to one of nine preliminary concerns categories. Individual comments were then assigned to one of 25 resource categories, introduced below, on the basis of the overall theme of the comment. Comments were received concerning the proposed withdrawal as well as concerning exploration and development activity. The official Scoping Report, detailing the scoping process, comment analysis, and issue development, was produced in March 2010 and made publicly available on the BLM's project website.

Air Quality

Concerns for air quality in the area of the Grand Canyon include potential impacts from limited or no withdrawal, including fugitive dust from vehicular travel associated with mines, and emissions from exploration and development activity, including greenhouse gas emissions. If Alternative A (No Action) were selected there would be the potential for air pollutant emissions to increase from the existing and anticipated addition of mineral exploration and mining operations.

Alternatives

The range of alternatives developed for the EIS should reflect the expressed interest in limited withdrawal options that would protect sensitive resources, but also keep exploration and development activity open yet restricted to areas relatively close to the communities that support mine development.

Cultural and American Indian Resources

The areas proposed for withdrawal are very rich in cultural and American Indian resources, including Traditional Cultural Properties or Places, sacred and traditional sites, and historic and archaeological resources. Protection of these resources was considered in the development of alternatives for the EIS.

Aquatic Wildlife

Concerns for aquatic wildlife include potential impacts of mineral exploration and development on fish habitat surrounding the Park as well as potential impacts on water quality of surface waters in the region and the implications for aquatic species within those waters.

Cumulative Impacts

The potential for cumulative impacts in the areas proposed for withdrawal extends from legacy exploration and development activity into future mine development and may include both beneficial and adverse impacts on resources such as water, sensitive species, soils, air quality, vegetation, wildlife, human health, and cultural resources.

Economic Conditions and Values

The economic condition of the area proposed for withdrawal is a considerable issue and concern. The EIS should consider general economic trends in the area, including employment, revenue generated by tourism and mineral exploration and development activity, and development in and around federal lands and how these trends may be impacted by any alternative selected.

Environmental Justice

Environmental justice, identified as disproportionate environmental and human health impacts to low-income and minority populations, is an issue within the areas proposed for withdrawal, especially with regard to the American Indian tribes and others living in the region.

Health and Safety

Human health and safety issues have the potential to affect local residents, members of the visiting and recreating public, and employees involved with uranium exploration and mining. Concerns for health and safety include exposure to radiation, miner safety, hazardous/toxic wastes, and potential contamination of area resources.

Lands

The proposed withdrawal area includes 982,552 acres of federal locatable minerals underlying public (BLM) land and National Forest System lands and 23,993 acres of federal locatable minerals underlying non-federal surface. Federal lands in the immediate vicinity of the proposed withdrawal include Grand Canyon National Park as well as two national monuments, a national recreation area, and four American Indian reservations. Issues regarding lands include multiple use and resource protection concerns for federal lands proposed for withdrawal as well as potential impacts on surrounding lands, both federal and non-federal.

Laws and Policies

Mining operations must comply with a variety of environmental and mining laws, including the 1872 Mining Law and BLM and Forest Service management plans. Compliance with federal law (including the National Environmental Policy Act [NEPA]), regulations, and policies and consideration of state and local statutes should be paramount in the development of the EIS.

Minerals

Issues regarding minerals, including the number of claims, quality of the mineral deposits, locatable mineral exploration and development activities, valid existing rights, and revenues associated with minerals, should be considered in the EIS.

Miscellaneous

Miscellaneous concerns that arose during scoping included requests for public involvement and full disclosure of the controversy surrounding the proposed withdrawal, as well as requests for an announcement of either support for or opposition to the proposed withdrawal and to uranium mining itself.

Natural Environment

Concern for the natural environment and the local and regional ecosystems in and near the proposed withdrawal area is a driving concern behind the proposed withdrawal.

Natural Resources

The proposed withdrawal area is rich in natural resources, including mineral and biological resources. Biological resources include timber, non-timber vegetation, and grazing range. Protection and development of these resources needs to be considered in the development of alternatives for the EIS.

Noise

Noise issues, such as the preservation of natural quiet soundscapes, include concerns about auditory intrusions into Grand Canyon National Park from machinery and equipment associated with uranium exploration and development.

Persons and Groups Affected

Groups affected by the proposed withdrawal include the BLM, U.S. Forest Service (Forest Service), National Park Service (NPS), and U.S. Environmental Protection Agency (EPA); state, local, and tribal governments; business and industrial organizations; and environmental groups. Persons affected include local citizens, including tribal members, members of the touring and recreating public, and citizens both national and international.

Recreation

Recreation concerns regarding the proposed withdrawal include access and the quality of recreation for both dispersed and developed recreation, personal recreation experiences, and illegal access by motorized recreation.

Social Conditions and Values

Issues related to social conditions include quality of life and well-being of local residents, the visiting public, and mine workers. Social values considered in the development of the EIS should include impacts on American Indian communities and lifeways, the preservation of natural and cultural resources for future generations, and impacts on the national heritage of the area.

Species of Concern

Issues associated with species of concern include the potential for exploration and mining to impact habitat for species of concern as well as individuals within populations. Specific species include California condors, black-footed ferrets, and Gunnison's prairie dogs.

Soils and Geology

Issues related to soils and geology also include concerns for paleontological resources. Other concerns considered in the EIS are the potential for the loss of topsoil and soil contamination from mineral exploration and development activities.

Transportation

Issues related to transportation include access road construction, vehicular traffic supporting mineral exploration and development, and conflicts between industrial and recreational vehicle activity.

Vegetation

Issues related to vegetation include concerns about the potential increase in noxious and invasive weeds, the loss of vegetation as wildlife habitat, and the general loss of vegetation through mineral exploration and development activity.

Visual Resources

The proposed withdrawal area is rich in scenic resources, including the vistas of the Grand Canyon. Issues related to visual resources include impacts on the scenic quality from mineral exploration and development activity, as well as concerns for visibility within the area.

Water Resources

Water resources addressed in scoping include ground and surface waters of the Grand Canyon watershed. Issues related to water resources include concerns about water quality and quantity, including contamination and/or depletion from uranium exploration and development activity, and potential impacts on riparian resources.

Wildlife

Issues related to wildlife include potential impacts on all wildlife species from exploration and development activities, as well as concerns about wildlife tolerance of contaminants that could result from the activities. Specific concerns were raised regarding impacts on game species, including mule deer, pronghorn, and turkeys, and impacts on game birds and migratory birds.

ALTERNATIVES

Alternatives are the heart of the EIS, as they present other several courses of action that could achieve the underlying purpose of and need for action to which the agency is responding. In this case, the underlying purpose of and need for action is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of locatable mineral exploration and development that could reasonably occur in the area. Alternatives must meet the purpose and need; be reasonable; provide a mix of resource protection, use, and development; and be responsive to the issues. Each action alternative is a withdrawal in which multiple use will continue with the exception of mining claim location and entry under the Mining Law of 1872. Under all alternatives, federal land will be managed in accordance with all applicable laws, regulations, and agency policy and guidance.

Comparison of Key Alternative Components

Proposed Withdrawal Parcel	**Alternative A No Action Area Open under the Mining Law**	**Alternative B Proposed Action (~1 Million Acres Withdrawn for 20 Years)**		**Alternative C Partial Withdrawal (~650,000 Acres Withdrawn for 20 Years)**		**Alternative D Partial Withdrawal (~300,000 Acres Withdrawn for 20 Years)**	
North	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	524,246	BLM	335,048	BLM	97,634
		FS*	3,466	FS	3,466	FS	3,466
		State	4,204	State	4,204	State	801
		Private	18,079	Private	9,248	Private	681
		Total	*549,995*	*Total*	*351,967*	*Total*	*102,581*
East	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	102,432	BLM	65,126	BLM	31,444
		FS	31,273	FS	24,360	FS	24,360
		State	0	State	0	State	0
		Private	749	Private	749	Private	429
		Total	*134,454*	*Total*	*90,234*	*Total*	*56,233*
South	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	0	BLM	0	BLM	0
		FS	321,135	FS	205,643	FS	132,867
		State	0	State	0	State	0
		Private	961	Private	961	Private	407
		Total	*322,096*	*Total*	*206,603*	*Total*	*133,274*
Total Acres of Federal Locatable Mineral Estate to Be Withdrawn:	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	626,678	BLM	400,174	BLM	129,078
		FS	355,874	FS	233,469	FS	160,693
		State	4,204	State	4,204	State	801
		Private	19,789	Private	10,958	Private	1,516
		Total:	**1,006,545**	**Total:**	**648,805**	**Total:**	**292,088**

* FS = Forest Service.

Alternative A, the No Action Alternative: the proposed withdrawal would not be implemented and the proposed withdrawal area would be open to location and entry under the Mining Law. New mining claims could be located, and exploration and mine development proposals would continue to be processed by the BLM or the Forest Service. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations. This alternative serves as the baseline for measuring the impacts of the other action alternatives and reflects the current management situation for all federal lands within the area proposed for withdrawal.

Alternative B, the Proposed Action: the proposed withdrawal would be implemented and the entire 1,006,545 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. New exploration and mine development proposals could continue to be authorized by the BLM or the Forest Service only on mining claims where valid existing rights are determined to exist, in accordance with applicable laws. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations. This is also the Preferred Alternative selected by the Secretary after review of public comment on the Draft EIS.

Alternative C, Partial Withdrawal: 648,805 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. New exploration and mine development proposals could continue to be authorized by the BLM or the Forest Service only on mining claims where valid existing rights are determined to exist, in accordance with applicable laws. This alternative would withdraw a large proportion of those areas, identified by analysis, having concentrations of cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development. Alternative C would leave the remaining portion of the proposed withdrawal area with isolated or lower concentrations of these resources open to operation of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

Alternative D, Partial Withdrawal: 292,088 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. New exploration and mine development proposals could continue to be authorized by the BLM or the Forest Service only on mining claims where valid existing rights are determined to exist, in accordance with applicable laws. This alternative would withdraw areas, identified by analysis, where there is a relatively high concentration of cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development (see also Figures 2.4-5 through 2.4-7 in Section 2.4.5). Alternative D would leave the remaining portion of the proposed withdrawal area with isolated or relatively low concentrations of these resources open to operation of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

PUBLIC INVOLVEMENT

The decision-making process is conducted in accordance with the requirements of the National Environmental Policy Act of 1969, Council on Environmental Quality regulations, and Department of the Interior and BLM regulations, policies, and procedures implementing NEPA and regarding withdrawals. NEPA and the associated regulatory and policy framework requires that all federal agencies involve interested groups of the public in their decision-making, consider reasonable alternatives to proposed actions, and prepare environmental documents that disclose the potential impacts of proposed actions and alternatives. Public involvement, consultation, and coordination have been at the heart of the NEPA process leading to this EIS. This was accomplished through public meetings, alternative means of comment submittal, news releases, a BLM maintained web site, and *Federal Register* notices.

The scoping process used for this EIS was initiated by publication of a Notice of Intent in the *Federal Register* on August 26, 2009. The formal period for submitting scoping comments was from August 26, 2009, through October 30, 2009, although scoping does not end until the EIS is completed. The BLM hosted two public meetings, one in Fredonia, Arizona, and one in Flagstaff, Arizona, in September and October 2009, respectively.

The Draft EIS was released for public review and comment by the BLM on February 18, 2011. The Draft EIS was distributed in both paper and electronic formats and was available for downloading from the BLM project website, at BLM and Forest Service offices, and at regional public libraries. The BLM invited public and agency comment on the DEIS for a period of 45 days. Four public meetings were held March 7 through March 10, 2011, in Phoenix, Flagstaff, and Fredonia, Arizona, and Salt Lake City, Utah, to present the DEIS to the public, answer questions about the document, and receive public comments. Upon receiving multiple requests to extend the 45-day comment period, the BLM extended the comment period to 75 days, ending on May 4, 2011.

BLM received a total of 296,461 comment submittals on the DEIS. Each submittal was read and all substantive comments were recorded into the electronic database. Comments were categorized into DEIS resource topics and general NEPA topics. All substantive comments were analyzed for potential content changes to the DEIS. Each comment received a response that outlines any change that was made for the FEIS or the rationale for no change.

AFFECTED ENVIRONMENT

Air Quality and Climate

The proposed withdrawal parcels are designated Class II areas for criteria pollutants. One federally designated Class I area, the Grand Canyon National Park, borders the proposed withdrawal parcels (see Figure 3.2-1 in Section 3.2). There are several other Class I and II areas in close proximity to the proposed withdrawal parcels. The proposed withdrawal parcels are classified as being in attainment for all criteria pollutants.

The air quality resource conditions likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the quantity of hazardous air pollutants emitted to the atmosphere; comparison of the maximum criteria pollutant concentrations with the National Ambient Air Quality Standards; comparison of the maximum criteria pollutant concentrations with the Prevention of Significant Deterioration air quality increments; greenhouse gas emissions; and air quality related values relative to visibility.

Geology and Mineral Resources

The proposed withdrawal area lies within the Colorado Plateau physiographic province. The primary economic mineral resource within the proposed withdrawal area consists of locatable mineral deposits, including both stratabound deposits and breccia pipe deposits. Stratabound deposits were studied and considered small and unattractive for commercial development. All other locatable deposits are associated entirely with breccia pipes. The uranium deposits within the northern Arizona breccia pipes are of higher grade than approximately 85% of the world's known uranium deposits. The lands within the proposed withdrawal area are considered to have a high potential for uranium with a high level of certainty. Resource conditions likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the availability of high mineral potential lands; number of ore deposits mined; potential for subsidence and alteration of geology or topography; amount of uranium mined as percent of known domestic resources, current domestic demand, and current domestic production; depletion of uranium resources within withdrawal area; amount of uranium mined as percent of global demand and production; and cumulative amount of high potential uranium resources lands withdrawn from exploration and development.

Water Resources

The study area for the water resources analysis includes local surface water drainage areas and groundwater basins that could potentially be impacted by reasonably foreseeable activities in the three proposed withdrawal parcels. Except for the main stem of the Colorado River, virtually all of the perennial surface water base flow in the study area, including the base flow for the Little Colorado River, is supported solely by flow from springs and seeps. Groundwater moves from areas of recharge to areas of discharge. In the study area, groundwater recharge occurs from infiltration of precipitation and ephemeral stream flow.

Resource conditions for water resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the quantity and quality of water discharge at springs that issue from perched groundwater zones that may be affected by operations at nearby mine sites, quantity and quality of water discharge at springs that issue from the regional R-aquifer system that may be depleted by operations at mine sites, and the quantity and chemical quality of receiving surface waters.

Soils

Soil types within the three proposed withdrawal parcels vary widely, reflecting differences in the environmental and geomorphic conditions under which soils were formed and differences in parent materials. The dominant soil orders that occur in the proposed withdrawal parcels are Alfisols, Aridisols, Entisols, and Mollisols. Resource conditions for soil resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include soil physical properties, soil erosion, and soil chemical quality.

Vegetation Resources

More than 300 plant species are endemic to the Colorado Plateau and the Colorado Plateau provides habitat for numerous vertebrates, many of which are identified as "species of greatest conservation need" by the Southwest Regional Gap Analysis Project. In addition, several plant species are listed as federally protected species. Vegetation communities in the proposed withdrawal parcels include riparian, Great Basin Grassland, Great Basin Desertscrub, Great Basin Conifer Woodland, and Petran Montane Conifer Forest.

Resource conditions for vegetation resources likely to be affected as a result of the exploration and development activities in the proposed withdrawal parcels include the amount of disturbance resulting in loss of vegetation, change in productivity, loss of diversity; degree of infestation of invasive species, degree and amount of fragmentation, degree and amount of contamination, and loss of water resources for vegetation.

Fish and Wildlife

The greater Colorado Plateau ecoregion supports a wide variety of terrestrial and aquatic wildlife species. With the exception of Kanab Creek on the Kaibab Plateau, perennial aquatic systems and associated riparian habitats are extremely rare within the proposed withdrawal area; therefore, fish and riparian-dependent wildlife species are naturally limited. Aquatic and riparian habitats are relatively abundant, however, immediately adjacent to the proposed withdrawal parcels along the Colorado River, seeps and springs, and associated drainages in Grand Canyon National Park.

Resource conditions for fish and wildlife likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and chemistry at aquatic sites); and the influence of these habitat changes on the reproductive success, population size, health, and diversity of organisms.

Special Status Species

Special status species within the proposed withdrawal area include 1) species listed as threatened or endangered, candidates considered for listing by the U.S. Fish and Wildlife Service or species managed under a conservation agreement; 2) BLM sensitive species; 3) Forest Service sensitive species; 4) NPS species of concern; and 5) Arizona Game and Fish Department species of greatest conservation need. Federally listed species, candidate species, and those with conservation agreements include 2 mammal species, 6 bird species, 5 amphibian or reptile species, 9 fish species and 1 invertebrate species. In addition to these, the BLM lists 11 plant species, 9 mammal species, 2 amphibian or reptile species, 4 fish species, 7 bird species, and 2 invertebrate species as sensitive. The Forest Service sensitive species list adds 3 plant species, 4 mammal species and 1 reptile species. The NPS sensitive species list adds 5 plant species, 5 mammal species, and 1 invertebrate species. The Arizona Game and Fish Department list adds 10 additional bird species as being species of greatest conservation need.

In addition to the resource conditions for fish and wildlife, resource conditions for special status species include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and chemistry at aquatic sites), which affect overall species health and abundance, as well as potential impacts to (modification or destruction of) designated critical habitat.

Visual Resources

Visual resources are the visible physical features on a landscape and may include land, water, vegetation, animals, structures, and other features. The combination of these physical features creates scenery and provides an overall landscape character. The proposed withdrawal area is internationally recognized for its diverse landscapes and scenic qualities and offers many developed and dispersed backcountry recreation opportunities for sightseeing, wildlife viewing, and on-road touring.

Resource conditions for visual resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include consistency with and conformity to designated BLM Visual Resource Management class objectives; consistency with and conformity to Forest Service scenic quality management or integrity objectives; consistency with and conformity to Park visual objectives from key viewpoints within the Park; and qualitative analysis of the potential changes to the darkness of the night sky in the proposed withdrawal parcels and Grand Canyon National Park.

Soundscapes

All three of the proposed withdrawal parcels border Grand Canyon National Park. The area is naturally quiet and generally not subject to modern sources of unnatural sound intrusion or noise. The Grand Canyon National Park Enlargement Act of 1975 established that natural quiet should be protected as a resource and value to the Park. Natural quiet, defined as the level of all natural sounds in an area, excluding all mechanical, electrical, and other human-caused sounds, is the baseline sound level used for this analysis.

Cultural Resources

Cultural resources are physical phenomena associated with past or present cultures and include archaeological sites and historic buildings and structures, as well as places of traditional religious and cultural importance. Cultural resources refer to both humanmade and natural physical features associated with human activity and, in most cases, are finite, unique, fragile, and nonrenewable. The proposed withdrawal parcels contain unique and distinctive resources that represent several themes important to history and prehistory. A Class I inventory of all known cultural resources within the three parcels was conducted to determine the nature of site type and distribution. Within the three parcels, 447 sites have been evaluated and recommended eligible for the National Register of Historic Places (NRHP); 12 sites have already been listed. To date, 196 sites have been determined ineligible for the NRHP; 1,880 sites have not yet been evaluated with respect to NRHP eligibility status.

Resource conditions for cultural resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the number of known historic properties (historic and prehistoric) to be affected, the number of acres to be disturbed by mineral exploration and development, the changes in settings or visual qualities that contribute to the integrity of cultural resource sites (evaluated qualitatively), and the degree to which reclamation practices can be used to restore the settings of sites.

American Indian Resources

American Indian resources refer to places regarded as important to American Indian cultures and traditions. These places may be individual landforms or large landscapes; they may be associated with sacred beings or ancestors, places where people came and still come to hunt game or gather plant resources, or archaeological sites. Known American Indian resources within the proposed withdrawal area include cultural landscapes; rivers, creeks, and springs; known activity areas; and trails and subsistence areas. Data on important places within the withdrawal parcels are presently available for the following American Indian groups: Southern Paiute (Las Vegas Paiute Tribe, Kaibab Band of Paiute Indians, Moapa Band of Paiute Indians, Pahrump Paiute Indian Tribe, Paiute Tribe of Utah, which includes the Shivwits Band of Paiute, and San Juan Southern Paiute Tribe), Havasupai Indian Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe, and Pueblo of Zuni.

Resource conditions for cultural landscapes and places are not easily definable or quantifiable. Some possible indicators include the proximity of traditional use areas to anticipated mineral exploration and development activity, the likelihood of concurrent or overlapping timing of traditional activity with mineral exploration and development activity, the manner and degree of auditory or visual disruptions in the traditional use area, and the number or acres of key springs, plants, or traditional use items lost or damaged as a result of exploration and development activity.

Wilderness

Designated wilderness areas are, by designation, withdrawn from mineral entry. There is one wilderness area adjacent to the North Parcel: Kanab Creek. There are two wilderness areas adjacent to the east parcel: Paria Canyon–Vermilion Cliffs and Saddle Mountain. There are no wilderness areas adjacent to the South Parcel. These wilderness areas currently provide a standard of solitude and naturalness that ranges from good to outstanding. They contain little to no evidence of surface disturbance, other than former vehicle ways and scattered signs of mining exploration. The basic resource condition indicators used to characterize wilderness are those indicators that reflect the characteristics that supported the wilderness designation. Resource conditions for wilderness likely to be affected as a result of the exploration and development activities in the proposed withdrawal parcels include changes in or to the tangible characteristics of wilderness: untrammeled, naturalness, undeveloped, and opportunities for solitude and primitive and unconfined recreation.

Wilderness Characteristics

Lands managed to maintain wilderness characteristics are not, by designation, withdrawn from mineral entry. There are approximately 12,846 acres of BLM lands managed to maintain wilderness characteristics all within the North Parcel of the proposed withdrawal area. The resource conditions used to characterize wilderness are those indicators that reflect the qualities lands with wilderness characteristics possess: land that has a high degree of naturalness, an outstanding opportunity for solitude, and an outstanding opportunity for primitive and unconfined recreation.

Recreation

Recreation activities occurring throughout the proposed withdrawal area involve a broad spectrum of pursuits, ranging from dispersed and casual recreation to organized, BLM-permitted and Forest Service–permitted group uses. The Arizona Strip is known for its large-scale undeveloped areas and remoteness. Typical recreation in the region includes off-highway vehicle driving, scenic driving, hunting, hiking, wildlife viewing, horseback riding, camping, backpacking, mountain biking, geocaching, picnicking, night-sky viewing, and photography. The area's proximity to the globally recognized Grand Canyon enables large numbers of U.S. residents and foreign visitors to access the public lands conveniently. Resource conditions for recreation resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include visitor use by activity and desired recreation experiences, acres within the BLM Recreation Opportunity Spectrum designation, and the miles, acres, or number of recreation sites that are currently designated in the proposed withdrawal area.

Social Conditions

The six-county socioeconomics study area for this EIS covers more roughly 50,000 square miles in northern Arizona and southern Utah. Population centers in Coconino and Mohave counties are generally located south of the proposed withdrawal area. With the exception of tribal communities located along travel routes, communities in the area tend to be located far from major transportation corridors and industrial centers, and in general the small towns and communities within the counties have maintained their rural character. American Indians who live within the study area reside predominantly in Coconino County and form part of the Navajo Nation, Hopi Tribe, Hualapai Tribe, Havasupai Indian Reservation, and Kaibab Band of Paiutes.

Mineral exploration activities; construction, operation, and maintenance of proposed uranium mine facilities; and/or the proposed withdrawal of mineral estates and the associated reduction in mineral exploration and development activity have the potential to affect social conditions. Resource conditions for social conditions likely to be affected as a result of exploration and development activities in the proposed withdrawal parcels include demographics, stakeholder values, public health and safety, and environmental justice.

Economic Conditions

The economic study area is generally rural, with two major urban centers (Flagstaff, Arizona, and St. George, Utah) within 75 miles of the proposed withdrawal areas. Federal lands constitute the majority of the area and all five counties have a large land area with a dispersed population. The Grand Canyon is a substantial natural barrier which effectively divides the study area into two separate geographic and economic sub-areas. All of the Utah counties (Garfield, Kane, San Juan, and Washington) are located in the North Study Area, along with small portions of Coconino and Mohave Counties of Arizona. The majority of the land area and population of Coconino and Mohave Counties lie in the South Study Area.

The North Study Area includes about 173,000 residents and 80,000 jobs. The economic base includes tourism, trade and regional services, retirement homes and construction, government employment and other activities. Mining is currently a significant part of the economic base only in San Juan County. Average earnings per job in the North Study Area are about 28% below average in the State of Utah. Communities of particular focus for this EIS include Fredonia, Kanab, Colorado City, the Kaibab Paiute Tribe, and Blanding.

The South Study Area includes about 316,000 residents and 150,000 jobs. The economic base includes tourism, trade and regional services, manufacturing, government employment and other activities.

Average earnings per job in the South Study Area are about 23% below average in the State of Arizona, but 20% higher than in the North Study Area. Communities of particular focus for this EIS include Tusayan, Page and Bitter Springs.

Resource conditions for economic conditions potentially affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include effects on economic activity (e.g., employment, gross regional product) related to changes in mining activity; effects on economic activity from tourism; effects on government revenues; effects on road condition and maintenance requirements; effects on energy resource production; and effects on recreation and environmental economic conditions.

ENVIRONMENTAL CONSEQUENCES

For ease of reading, the impacts of mineral exploration and development activities on a specific resource under a particular alternative, as presented in Chapter 4, are generally characterized as no impact, minor, moderate, or major. This represents comparison to the status quo or baseline for that resource. However, in order to properly and meaningfully evaluate the impacts of each withdrawal alternative, the impacts expected from mining under that alternative should be measured against the impacts projected to occur under Alternative A, which is the baseline for purposes of comparison of the alternatives to one another, as it represents the amount of reasonably foreseeable mineral development should no withdrawal take place.

Impacts on Air Quality and Climate

Under all alternatives, pollutants would be emitted into the atmosphere during the mine operation activities. The amount of pollutants emitted would depend on the volume of mineral exploration and development activity under each alternative. Under Alternative A (No Action), impacts would be the greatest, compared with the alternatives. Modeling results demonstrate that plume impacts from a typical mining operation are below absolute contrast value but exceed the contrast limit (i.e., ΔE). Current governing laws and regulations would require any future exploration and development activities to demonstrate that the proposed activity would not impact Class I areas such as Grand Canyon National Park, and a Level 2 analysis would be required to determine potential impacts on the Park.

Impacts on Geology and Mineral Resources

Alternative A would have no impact on the current management policies of the proposed withdrawal area, and therefore extensive impact on underground geological conditions and extensive depletion of uranium resources from unrestricted mining of uranium would occur. *Alternative B* would reduce the number of ore deposits mined but would not change the potential for subsidence or alteration of geology or topography in the proposed withdrawal area. *Alternatives C* and *D* would also reduce the number of ore deposits mined but would not reduce the number as much as *Alternative B. Alternatives B, C,* and *D* would also cause a moderate to major long-term impact to the availability of mineral resources and depletion of uranium resources within the proposed withdrawal area.

Impacts on Water Resources

The degree of impact on water resources varies, depending on the number and location of mines, and is specific to each water resource condition and local groundwater and surface water sub-basin. Under all alternatives, impacts range from none to major and impact duration ranges from short to long term, depending on the resource condition considered. Duration of impacts is generally long term for groundwater and ranges from short to long term for surface water under all alternatives.

Potential impacts to water resources would be expected to be largest overall under *Alternative A* and smallest under *Alternative B.* Potential impacts to water resources under *Alternatives C and D* are generally larger than those projected under *Alternative B,* but generally smaller than impacts under *Alternative A*. The magnitude of reduction in potential impacts under *Alternatives B, C, and D* compared to those projected under *Alternative A* is related to the scale of and possible locations for anticipated mining operations in each parcel. Thus, impacts are generally largest in the North Parcel under all alternatives compared to the other parcels because substantial new exploration and development activity is foreseen throughout the parcel, regardless of the proposed withdrawal. Similarly, impacts are generally smallest in the East Parcel because less mineral development is foreseen; no impacts to water resources are projected to occur under *Alternative B* because no mines are anticipated to be developed.

The impact on perched aquifer groundwater is none or negligible under all alternatives and parcels, except in the North Parcel where it ranges up to moderate (*Alternatives C and D)* or major (Alternative A). The impact on deep aquifer springs is none or negligible under all alternatives, except where it ranges up to moderate for water quality in the North Parcel (*all alternatives*) and East Parcel (*Alternatives A, C,* and *D*), and where it ranges up to major for the small South Rim springs near the South Parcel (*Alternative A*). The potential impact to South Rim springs would be eliminated under Alternatives B, C, and D because no mines would be expected to be located within their groundwater drainage areas. Under all alternatives, the impact on deep wells at Tusayan, Arizona (South Parcel), is negligible for water quantity and none to major for water quality. The impact on surface water under *Alternative A* ranges from negligible to moderate, except where it ranges up to major for quantity and quality in the South Parcel. The impact on surface water under *Alternatives B* and *C* is none or negligible, except where it ranges up to moderate in the North Parcel. The impact on surface water under *Alternative D* is none or negligible, except where it ranges up to moderate in the North and South parcels. Potential impact on the Colorado and Virgin rivers across all alternatives is none or negligible and of short-term to long-term duration.

Impacts on Soils

The magnitude, extent, and duration of impacts to soil resources depend on the amount of disturbed area exposed to water and wind, soil types affected, topography at sites of disturbance, duration of individual exploration or development operations, and success of reclamation efforts at each area of operation. Disturbance of soils could result in reduced productivity and increased erosion, which would generally be minor and limited to the vicinity of sites of disturbance. Duration of such impacts would be expected to be long term for soil productivity and short term for increased erosion. Impacts from distribution of mine-related constituents in soil would generally be limited to the vicinity of mine sites but would be long term. Potential impacts to soils under *Alternative A* range from minor to moderate in all three parcels because some mines might be located in areas with sensitive soils or where increased erosion and contaminant distribution might extend beyond the vicinity of sites of activity. Potential impacts to soils under *Alternative B* are minor to moderate in the North Parcel because substantial new exploration and development activity is foreseen throughout the parcel, regardless of the proposed withdrawal; impacts are none in the East Parcel because no mining-related exploration or development is foreseen; and impacts are minor in the South Parcel, where all sensitive areas would be withdrawn. Potential impacts to soils under *Alternative C* are minor to moderate in the North Parcel and minor in the East and South parcels because nearly all sensitive areas would be withdrawn. Potential impacts to soils under *Alternative D* are minor to moderate in the North Parcel and minor to moderate in the East and South parcels because a few sensitive areas are not withdrawn.

Impacts on Vegetation Resources

Impacts on vegetation are expected to occur under each alternative. The magnitude of these impacts will vary, depending on the location of the mine and associated roadway and transmission line facilities.

Depending on the location of the mine facilities, impacts could range from minor to moderate and have the potential to be measurable but not apparent. The acres disturbed under *Alternative B* would be an approximate decrease of 88%, compared with *Alternative A*; acres disturbed under *Alternative C* would be a 61% decrease, compared with *Alternative A*; and acres disturbed under *Alternative D* would be a 30% decrease, compared with *Alternative A.* All alternatives would have a minor long-term impact on the productivity of aquatic and terrestrial habitats.

Impacts on Fish and Wildlife

Impacts on wildlife habitat and habitat fragmentation are expected to occur under each alternative. The magnitude of these impacts will vary, depending on the location of mines and overall water quality and quantity impacts to area seeps, springs, and other water bodies. The following impacts discussion is meant to compare the alternatives. *Alternative A* would have a minor to major long-term impact on aquatic and terrestrial habitats and a minor long-term impact on unfragmented habitat. *Alternatives B* and *C* would have minor long-term impacts on aquatic and terrestrial habitats and minor long-term impacts to unfragmented habitat as a result of the decrease in acres disturbed, compared with *Alternative A. Alternative D* would have a moderate impact to aquatic and terrestrial habitats and a moderate long-term impact to unfragmented habitat as a result of the decrease in acres disturbed, compared with *Alternative A.* The increase in the levels of uranium and its decay constituents in water and soil is anticipated to be minor and long term under all alternatives. While these increased levels may impact individuals, impacts are not anticipated to alter overall fish and wildlife populations. Impacts to sensitive aquatic habitats, such as Kanab Creek, are anticipated to be reduced under *Alternatives B, C,* and *D* because a greater area is being withdrawn from location under the mining law.

Impacts on Special Status Species

Impacts on special status species are expected to occur under each alternative. The magnitude of these impacts will vary, depending on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. *Alternative A* would have a minor to major long-term impact on aquatic and terrestrial habitats. *Alternatives B* and *C* would have minor long-term impacts on aquatic and terrestrial habitats as a result of the respective decrease in acres disturbed, compared with *Alternative A. Alternative D* would have a moderate impact on aquatic and terrestrial habitats as a result of the decrease in acres disturbed, compared with *Alternative A.* The increase in the levels of uranium and its decay constituents in water and soil is anticipated to be minor and long term under all alternatives. While these increase levels may impact individuals, impacts are not anticipated to alter special status species populations. Impacts on sensitive aquatic habitats, such as Kanab Creek, are anticipated to be reduced under *Alternatives B, C,* and *D* because more area is being withdrawn from location under the mining law.

Impacts on Visual Resources

The degrees of contrast and impact vary and are specific to each viewpoint, ranging from temporary to major and short to long-term under all alternatives. *Alternative A* does not withdraw any sensitive visual designations (Class II, High), resulting in a moderate long-term impact on the conformance with BLM and Forest Service visual management objectives and a minor to moderate long-term impact on the conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative A* would have a minor to moderate short-term impact on changes in night sky within the proposed withdrawal area. *Alternative B* would withdraw all of the sensitive visual designations, resulting in conformance with BLM and Forest Service visual management objectives and conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative B* would have no impact to minor short-term impact on changes in night sky within the proposed withdrawal area. *Alternative C* would withdraw approximately 88% of the sensitive visual designations, resulting in a minor long-term impact on the conformance with BLM and Forest Service visual management objectives and on the conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative C* would have a minor short-term impact on changes in night sky within the proposed withdrawal area. *Alternative D* would withdraw approximately 54% of the sensitive visual designations, resulting in a minor long-term impact on the conformance with BLM Visual Resource Management class objectives and a minor to moderate long-term impact on the conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative D* would have would have a minor to moderate short-term impact on changes in night sky within the proposed withdrawal area.

Impacts on Soundscapes

Mineral exploration and development of a proposed mine site would cause temporary increases in ambient noise levels in the immediate vicinity of the exploration and development sites for all alternatives. Impacts on soundscapes within the proposed withdrawal area range from minor to moderate long-term impacts, depending on the location and level of mining-related exploration and development.

Impacts on Cultural Resources

Under all alternatives, mining activities could cause direct impacts to historic and prehistoric sites, which would be mitigated through established regulations and policies. Under current regulations and policies, any proposed project would require an individual assessment of the impacts to cultural resources and mitigation of adverse impacts if possible; however, available mitigation measures may only be able to reduce adverse impacts to sites and, in some cases, mitigation is not possible due to the nature of the project or resources. The primary mitigation measure for both the BLM and Forest Service would be avoidance. If complete direct impact mitigation is not possible, future mining activities could have major direct impacts on sites within all parcels under Alternatives A and D; within the North Parcel (with minor direct impact on the South Parcel and no direct impact on the East Parcel) under Alternative B; and within the North and East parcels (with minor direct impact on the South Parcel) under Alternative C. All alternatives would have minor short-term indirect impacts to historic and prehistoric sites as a result of visual and auditory impacts to the sites if exploration or mining occurred near them.

Impacts on American Indian Resources

There are no tribal trust resources or assets within the proposed withdrawal area; however, all alternatives could result in long-term indirect impacts of unknown magnitude on Havasupai Springs, which is located outside the proposed withdrawal area. The types of known resources for traditional cultural practices and uses in the proposed withdrawal area include landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, camps, and traditional use plants and animals. *Alternative A* would have a major long-term direct impact on resources on all three parcels including disturbance to a Traditional Cultural Property or Place, minor short-term visual and auditory (indirect) impacts, and major long-term visual impacts from power lines. *Alternative B* would have major long-term direct impacts to resources on the North Parcel, no direct impacts on resources in the East Parcel, minor long-term direct impacts on the South Parcel, minor long-term visual and auditory (indirect) impacts on the North and South parcels, and major long-term visual impacts from power lines on the North and South parcels. *Alternative C* would have major long-term direct impacts on resources on the North and East parcels in areas excluded from withdrawal, minor long-term direct impacts on the South Parcel, minor long-term visual and auditory (indirect) impacts on all three parcels, and major long-term visual impacts from power lines on the North and South parcels. Since the majority of resources would be outside the withdrawal boundaries, *Alternative D* would have major long-term direct impacts to resources on all three parcels, including disturbance to a Traditional Cultural Place, minor short-term visual and auditory (indirect) impacts on all three parcels, and major long-term visual impacts from power lines on all three parcels.

Impacts on Wilderness

Under all alternatives, there would be no direct impacts on designated and proposed wilderness areas. Potential indirect impacts to designated and proposed wilderness range from minor to moderate and from short-term to long-term depending on the proximity to designated wilderness of lands that are proposed for withdrawal, and the density of specific existing and valid existing rights for mineral exploration and mining activity that would be anticipated to occur. A withdrawal alternative that still results in the occurrence of mining activies closer to designated or proposed wilderness areas would have a greater potential impact than those occurring farther away.

Impacts on Wilderness Characteristics

Under all alternatives, there would be direct impacts on lands possessing or managed to maintain wilderness characteristics since varying levels (dependent upon alternatives) of mineral development may occur and would detract from the land's existing high degree of naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation if the mineral development were in the immediate vicinity of (adjacent to) the lands managed to maintain wilderness characteristics. The decrease in mining-related activity that would accompany the proposed withdrawals under Alternatives B, C, and D would result in an indirect, but beneficial impact to wilderness characteristics, since there would be decreases to activities that may detract from the land's wilderness characteristics. Potential indirect impacts to wilderness characteristics range from minor to moderate and from short term to long term, depending on the placement and density of specific existing and valid existing rights for mineral exploration and mining activity that would be anticipated to occur. A withdrawal alternative that still results in the occurrence of mining activies closer to lands possessing or managed to maintain wilderness characteristics would have a greater potential impact than those occurring farther away.

Impacts on Recreation

Alternative A's no-withdrawal scenario would result in increases to the road density more than the other alternatives and would increase visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would be moderately impacted by exploration and development activity. The haul traffic associated with a no-withdrawal scenario on State Route 64 would be moderate and would have a long-term impact on visitors driving to Grand Canyon Village. *Alternative B's* withdrawal would result in a 63% decrease in new roads compared to Alternative A, resulting in minor increases to the existing road density and visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would experience minor impacts from exploration and development activity. Impacts to visitor use on State Route 64 would be minor and long term. *Alternative C's* withdrawal would result in a 45% decrease in new roads compared to Alternative A, resulting in minor increases in road density and the impacts on visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would be moderately impacted by exploration and development activity. Impacts on visitor use on State Route 64 would be moderate and long term. *Alternative D's* withdrawal would result in a 14% decrease in new roads compared to Alternative A, resulting in moderate impacts to the road density and would have a moderate impact to visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would be moderately impacted by exploration and development activity. Impacts to visitor use on State Route 64 would be moderate and long term.

Impacts on Social Conditions

Alternative A could result in minor, long-term direct and indirect impacts to demographics based on an estimated population increase over current conditions (2010 Census data). There are no anticipated impacts to demographics under *Alternative D,* as conditions for Alternative D compared to Alternative A are relatively similar. However, *Alternatives B and C* could result in minor long-term impacts as a result of potential decreases in population from *Alternative A* due to decreased mineral activity and associated employment. In terms of stakeholder values, impacts on different groups (i.e., those who support mineral exploration and development activity or those who support withdrawal) depend on the groups' perspective and the level of exploration and development activity under each alternative; generally, impacts range from minor to moderate and would be long term. Similarly, impacts on health and human safety range from no measurable impacts to minor or moderate long-term impacts, depending on the level of exploration and development activity; the more exploration and development activity under a given alternative, the more potential risk for health or human safety impacts there is. Ten communities, including five tribes meet the criteria for an environmental justice population. There would be no environmental justice impacts under *Alternatives B and C*; however, *Alternatives A* and *D* could result in minor, long-term disproportionate health impacts to environmental justice communities.

Impacts on Economic Conditions

Each alternative would have larger effects on economic conditions in the North Study Area than the South Study Area. Mining-related economic activity is projected to increase gross regional product in the North Study Area by almost 3%, and employment by almost 1%, under *Alternative A*. Relative effects in the smaller communities closest to the proposed north withdrawal area would likely be larger. Including multiplier effects, uranium mining is projected to support approximately 636 jobs under Alternative A (combined estimate across both Study Areas). Including multiplier effects, Alternatives B, C and D are projected to decrease uranium mining-related employment by approximately 465 jobs, 294 jobs and 104 jobs, respectively (relative to Alternative A). Mining-related activity in both Study Areas, combined, is projected to increase annual revenues to the federal government, state governments, and local governments by about $23 million under Alternative A. Alternatives B, C, and D are projected to reduce annual government revenues by approximately $16.6 million, $10.5 million and $3.5 million, respectively, compared to Alternative A. Average annual uranium production under *Alternative A* could increase overall domestic production from 8% to 17% of current U.S. demand. The reduction in uranium production under Alternative B would be equivalent to about 6% of current U.S. demand. Uranium production would be reduced by about 4% of current U.S. demand under Alternative C and about 2% of current U.S. demand under Alternative D. Each of the withdrawal alternatives *(Alternatives B, C and D)* is projected to have a minor positive effect on the tourism-related economy and a similar minor positive effect on the economic benefits received by recreational visitors to the study area. The tourism industry in the North Study Area supported 8,306 jobs (approximately 10% of total jobs in the area) and contributed over a quarter of a billion dollars to gross regional product in 2008, not including any tourism visits unrelated to NPS-managed facilities. Tourism associated with NPS-managed lands in the South Study Area is a significant contributor to the overall regional economy. Visitors and NPS payroll generated 12,868 jobs (9% of total jobs) and added $380 million to gross regional product in 2008. Not surprisingly, Grand Canyon National Park creates the largest economic impact supporting 9,600 jobs and generating $258 million in value added in the South Study Area. Based on currently available information, effects on the existence value of the Grand Canyon or the economic value of ecological services provided by the Canyon cannot be quantified under any of the alternatives.

CONTENTS

Appendices*

** The Appendix volume for this FEIS is only available electronically. It may be downloaded from the BLM project website (http://www.blm.gov/az/st/en/prog/mining/timeout.html) or requested by mail from Mr. Chris Horyza, BLM Project Manager, Arizona State Office, Bureau of Land Management, One North Central Avenue, Suite 800, Phoenix, AZ 85004, or by calling 602-417-9446 or emailing choryza@blm.gov.*

Figures

Tables

ACRONYMS AND ABBREVIATIONS

BLM

Arizona Strip FEIS	*Arizona Strip Final Environmental Impact Statement* (BLM 2007)
Arizona Strip ROD/RMP	*Arizona Strip Field Office Record of Decision and Approved Resource Management Plan* (BLM 2008b)

Forest Service

Kaibab EA	*Environmental Assessment for Amendment of the Kaibab National Forest Management Plan—Recreation and Scenery Management* (Forest Service 2004)
Kaibab LRMP/ROD	*Kaibab National Forest Land and Resource Management Plan, as Amended, and Record of Decision* (Forest Service 1988)

Other Abbreviations

°F	degrees Fahrenheit
%	percent
#	number of
ΔB_{ext}	light extinction
ΔE	delta E
4WD	4-wheel-drive
^{235}U	uranium 235
^{238}U	uranium 238
AAC	Arizona Administrative Code
ACEC	Area of Critical Environmental Concern
ADEQ	Arizona Department of Environmental Quality
ADMMR	Arizona Department of Mines and Mineral Resources
ADOC	Arizona Department of Commerce
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
AIRFA	American Indian Religious Freedom Act
AMA	active management area
amsl	above mean sea level
AQMP	air quality management plan
AQRV	Air Quality Related Value
APP	Aquifer Protection Program
ARS	Arizona Revised Statutes
ASLD	Arizona State Land Department
ATV	all-terrain vehicle
avg	average
AZGS	Arizona Geological Survey
BADCT	best available demonstrated control technology
BEA	Bureau of Economic Analysis
BEIR	Biological Effects of Ionizing Radiation
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
bls	below land surface

BMP	best management practice
BSFC	brake specific fuel consumption
C	Candidate
Ca	calcium
CA	Conservation Agreement
CAA	Clean Air Act
CAFÉ	Corporate Average Fuel Economy
CARB	California Air Resources Board
CDP	Census designated place
Census Bureau	U.S. Census Bureau
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH	critical habitat
CH_4	methane
Cl	chloride
CO	carbon monoxide
CO_2	carbon dioxide
CWA	Clean Water Act
CWMA	Cooperative Weed Management Area
dB	decibel
dBA	decibel “A-weighted” sound level
DEM	digital elevation model
Denison	Denison Mines (USA) Corporation
E	Endangered
EA	environmental assessment
EF	emission factor
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FLPMA	Federal Land Policy and Management Act
Forest Service	U.S. Forest Service
FY	fiscal year
GA	geographic area
GCNRA	Glen Canyon National Recreation Area
GHG	greenhouse gas
GIS	geographic information system
GMU	game management unit
gpd/foot	gallons per day per foot width of aquifer
gpm	gallons per minute
GRP	Gross Regional Product
GTES	General Terrestrial Ecosystem Survey
GWP	global warming potential
GWSI	ADWR Groundwater Site Inventory

HAP	hazardous air pollutant
Harshbarger	Harshbarger and Associates
HC	hydrocarbon
HCO_3	bicarbonate
hp	horsepower
HR	House of Representatives
hr	hour
I-	Interstate
IMPROVE	Interagency Monitoring of Protected Visual Environments
I/O	input/output
L	liter(s)
L_{dn}	day-night average noise level
L_{eq}	equivalent noise level
L_{max}	maximum sound pressure level
L_n	percentile noise level
LSA	low specific activity
m	meter(s)
Max	Maximum
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
$\mu g/m^3$	microgram(s) per cubic meter
µg/L	microgram(s) per liter
µg/min	micrograms per minute
µR/h	microrad(s) per hour
Mg	Magnesium
mGy/h	milligray per hour
mg/L	milligram(s) per liter
mg/m^3	milligram(s) per cubic meter
mgal	million gallons
MHI	median household income
Min	minimum
Mining Law	General Mining Law of 1872
MIS	Management Indicator Species
Montgomery	Errol L. Montgomery and Associates, Inc.
µPa	micropascals
mpg	mile(s) per gallon
mph	mile(s) per hour
mrem	millirem(s)
mrem/yr	millirems per year
MSHA	Mine Safety and Health Administration
Mt.	Mount
MW	molecular weight
Na	sodium
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NAU	Northern Arizona University
N/D	not determined

NEPA	National Environmental Policy Act
NFMA	National Forest Management Act of 1976
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NO	nitrogen monoxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NP	no projection available at this geographic level
NPS	National Park Service
NR	not reported
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSA	noise-sensitive area
NSR	New Source Review
NURE	National Uranium Resource Evaluation
NVUM	National Visitor Use Monitoring
O_3	ozone
OHV	off-highway vehicle
OSHA	Occupational Safety and Health Administration
PAC	Protected Activity Center
Park	Grand Canyon National Park
Pb	lead
pCi/g	pico-Curie per gram
PCPI	per capita personal income
PEL	permissible exposure level
PL	Public Law
$PM_{2.5}$	fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers
PM_{10}	particulate matter with a nominal aerodynamic diameter of less than 10 micrometers
ppb	part(s) per billion
ppm	part(s) per million
PSD	prevention of significant deterioration
PSL	potential soil loss
RDP	radon decay product
Reclamation	U.S. Bureau of Reclamation
rem	roentgen equivalent man
Resource Advisory Council	Bureau of Land Management Arizona Resource Advisory Council
RFD	reasonably foreseeable development
RM	river mile
RMIS	Recreation Management Information System
RMP	resource management plan
RN	roaded natural
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum

S	Sensitive
SC	Species of Concern
SCAQMD	South Coast Air Quality Management District
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Office
SIL	significant impact level
SIO	Scenic Integrity Objective
SIP	State Implementation Plan
SMS	Scenery Management System
SO_2	sulfur dioxide
SO_4	sulfate
SPM	semi-primitive motorized
SPNM	semi-primitive non-motorized
SR	State Route
SRL	Soil Remediation Level
SSURGO	Soil Survey Geographic
STATSGO	State Soil Geographic
SWCA	SWCA Environmental Consultants
SWDI	Shannon-Weaver Diversity Index
T	Threatened
TCP	Traditional Cultural Property or Place
TDS	total dissolved solids
tpd	ton(s) per day
TES	Terrestrial Ecosystem Survey
tpy	ton(s) per year
TSL	tolerance soil loss
TSP	total suspended particulate
U_3O_8	uranium
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality
U.S.	U.S. Route
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VANE	VANE Minerals, Inc.
VOCs	volatile organic compounds
VQO	Visual Quality Objective
VRM	visual resource management
w/	with
w/o	without
WEG	Wind Erodibility Group
WEI	Wind Erodibility Index
WTP	willingness to pay
yr	year

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Chapter 1

INTRODUCTION: PURPOSE OF AND NEED FOR ACTION

1.1 INTRODUCTION

On July 21, 2009, the Department of the Interior published notice of the Secretary of the Interior (Secretary) Ken Salazar's proposal to withdraw (proposed withdrawal) approximately 1 million acres of federal locatable minerals in northern Arizona from the location of new mining claims under the Mining Law of 1872 [30 United States Code (USC) 22–54] (Mining Law), subject to valid existing rights. The withdrawal was proposed in response to increased mining interest in the region's uranium deposits, as reflected in the recent increase in the number of new mining claim locations, and concern over potential impacts of uranium mining to the Grand Canyon watershed, adjacent to Grand Canyon National Park (the Park).

Under Section 204 of the Federal Land Policy and Management Act (FLPMA), publication of the *Federal Register* notice of the proposed withdrawal (Appendix A) had the effect of segregating the lands involved for up to 2 years from the location and entry of new mining claims while the Bureau of Land Management (BLM) evaluated the withdrawal application. This 2-year time frame, which began on July 21, 2009, was to be used to complete various studies and analyses of resources in the area proposed for withdrawal, including environmental review of the proposed withdrawal under the National Environmental Policy Act of 1969, as amended [42 USC 4321–4347] (NEPA). These studies and reviews would provide the basis for a final decision by the Secretary of the Interior regarding whether or not to proceed with the proposed withdrawal or to select an alternative action. Although a Draft EIS was published on February 18, 2011, the NEPA process had not concluded before the 2-year segregation expired on July 20, 2011. Therefore, to allow for closure of the NEPA process, the Secretary issued a 6-month emergency withdrawal of the identified areas (PLO 7773) effective July 21, 2011. This emergency withdrawal is due to expire January 20, 2012.

The proposed withdrawal, serialized as BLM casefile AZA-35138, constitutes a federal action subject to the requirements of NEPA. BLM is the lead agency processing the proposed withdrawal application and preparing the associated NEPA analysis, in this case an environmental impact statement (EIS). The EIS addresses the potential direct, indirect, and cumulative effects on the human environment of the proposed withdrawal and alternatives to the proposed withdrawal. The EIS also discloses any unavoidable adverse impacts, impacts to the long-term productivity of affected resources, and any irreversible or irretrievable commitments of resources that result from the proposed withdrawal or the alternatives to the proposed withdrawal, including the No Action Alternative.

The Proposed Action would withdraw an estimated 1,006,545 acres of federal locatable minerals underlying lands in the vicinity of Grand Canyon National Park and that border the Park in some locations. The land proposed for withdrawal is contained within three parcels: the North Parcel, with approximately 549,995 acres; the East Parcel, with approximately 134,454 acres; and the South Parcel, with approximately 322,096 acres (Figure 1.1-1). The North and East parcels are both north of the Park, while the South Parcel is south of the Park. The proposed withdrawal has no effect on mine development of any non-federal mineral estate within the exterior boundaries shown in Figure 1.1-1; however, non-federal lands are included in the event that they are subsequently acquired by the federal government.

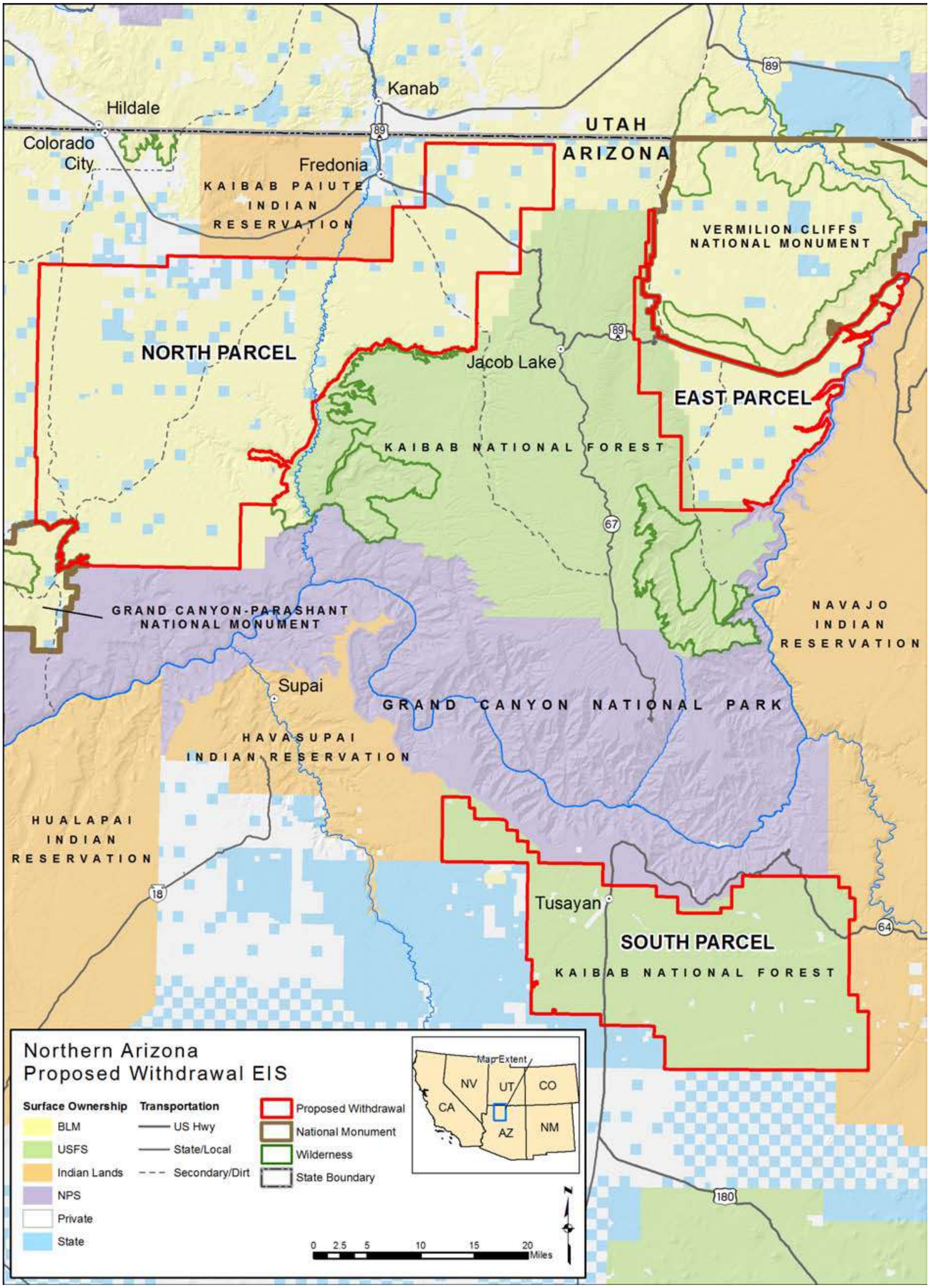


Figure 1.1-1. Proposed withdrawal area.

Approximately 982,552 acres within the boundaries of the proposed withdrawal are managed by the BLM or the U.S. Forest Service (Forest Service). The remaining 23,993 acres are split estate lands where the surface is non-federal but the locatable minerals are owned by the federal government. The proposed 20-year withdrawal would apply to all minerals locatable under the Mining Law, regardless of surface ownership. The proposed withdrawal would not apply to non-federal mineral estate or to leasable or salable minerals (e.g., oil and gas leasing, sand and gravel permits), which are not subject to appropriation under the Mining Law.

Acreage of federal locatable minerals proposed for withdrawal is shown, by parcel, in Table 1.1-1 and in Figure 1.1-2. The table also identifies those acres of federal locatable minerals located beneath non-federal surface that are either State owned or private.

Table 1.1-1. Acreage, by Parcel, of Federal Locatable Minerals Proposed for Withdrawal

	North Parcel	East Parcel	South Parcel
Federal locatable minerals underlying federal surface	524,246	133,705	321,135
Federal locatable minerals underlying non-federal surface	25,749	749	961
Total	**549,995**	**134,454**	**322,096**

The proposed withdrawal is subject to valid existing rights that are determined to exist on those mining claims located prior to July 21, 2009, the date the lands were segregated from location and entry under the Mining Law by the publication of the notice of proposed withdrawal in the *Federal Register*. The general principles and requirements for locating and developing mining claims, as well as procedures for determining valid existing rights, are described in Appendix B.

1.2 BACKGROUND

In 2007, the demand for uranium pushed the commodity price to over $130/lb before returning to the low $40/lb range in 2009. This price spike prompted new interest in the breccia pipe uranium deposits located on federal lands to the north and south of Grand Canyon National Park, causing thousands of new mining claims to be located in the area. Along with the increase in new mining claim locations came greater public concern that uranium mining could adversely affect natural, cultural, and social resources in the Grand Canyon watershed, which includes resources in Grand Canyon National Park.

In response to the concern over potential environmental effects, a number of events occurred in 2008 and 2009 to bring attention to these lands and the potential for long term or permanent impacts to the Grand Canyon watershed. Among those events was legislation introduced by Representative Grijalva (D-AZ) in March 2008 to permanently withdraw essentially these same lands from location and entry under the Mining Law, as well as from mineral leasing and from mineral material sales and disposal. The area proposed for legislative withdrawal is located in northern Arizona and includes federal lands north of Grand Canyon National Park administered by the BLM Arizona Strip Field Office and lands south of the Park in the Tusayan Ranger District administered by the Forest Service. The most recent bill [House of Representatives (HR) 855] for a legislative withdrawal was introduced in March 2011.

On July 21, 2009, the Department of the Interior published notice of the Secretary of the Interior's proposed 20-year withdrawal under the authority of the FLPMA. Consistent with Section 204(b) of FLPMA and BLM's regulations at 43 CFR 2091.5-1(a), publication of the notice of the proposed withdrawal segregated the lands within the boundaries specified in the notice from location of new

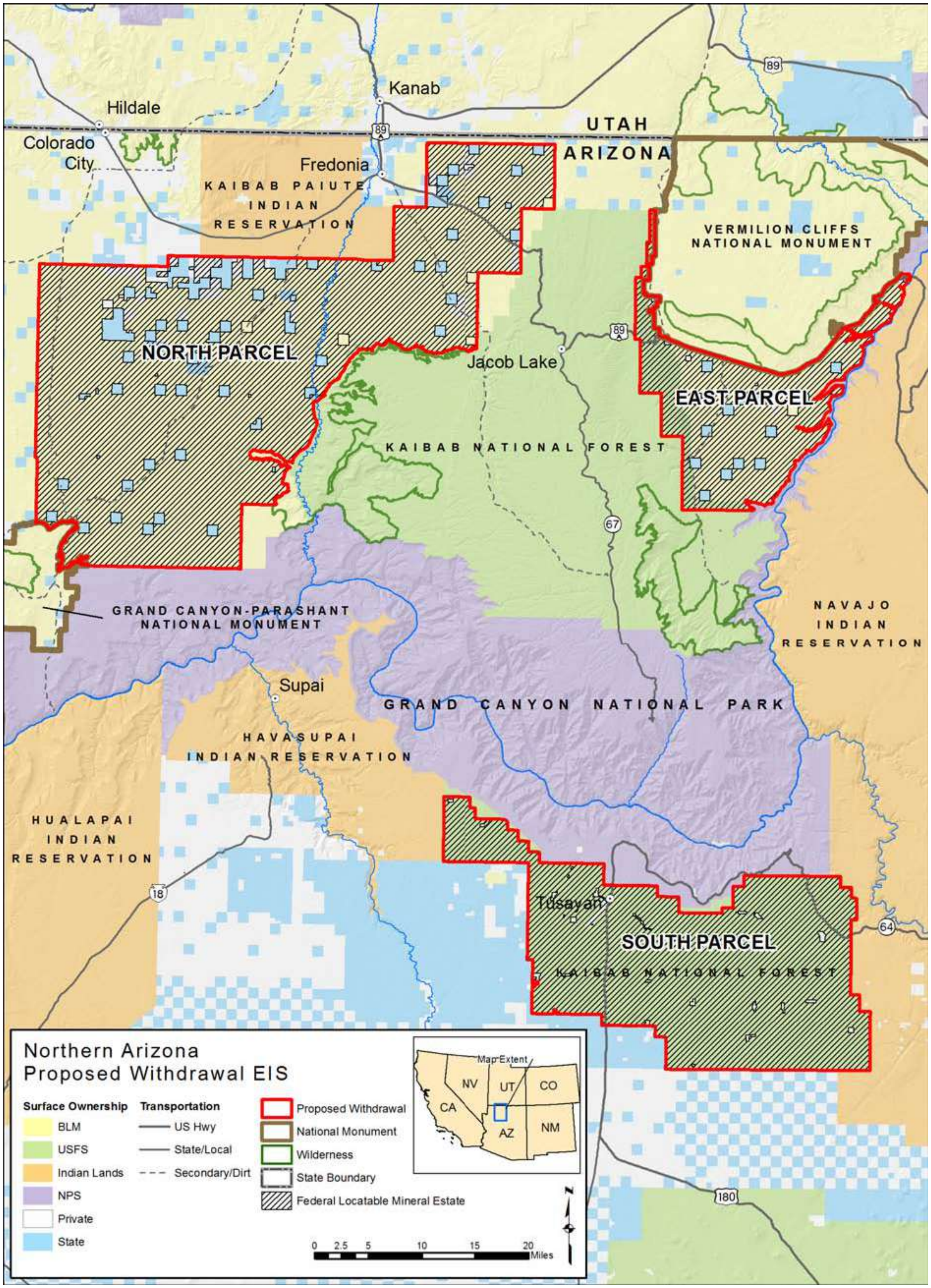


Figure 1.1-2. Federal locatable minerals proposed for withdrawal.

mining claims under the Mining Law for 2 years. The Secretary's proposed withdrawal was published on July 21, 2009, and initiated the 2-year segregation (or time-out) on the location of new mining claims; to allow time for completion of the NEPA process, a 6-month emergency withdrawal of the identified areas went into effect on July 21, 2011. The Secretary's proposed 20-year withdrawal covers essentially the same area as the legislative withdrawal proposed in 2008; however, under the Secretary's proposal, the subject lands would only be withdrawn from location under the Mining Law and would remain available for mineral leasing and mineral materials sales.

The 2-year segregation did not, and the emergency withdrawal does not, prohibit continuation of existing mineral exploration and development activity, or the approval of new mining on existing mining claims, provided that those claims were valid as of July 21, 2009, and have remained valid. As of August 2011, there were approximately 3,350 mining claims located within the three parcels proposed for withdrawal.

During the segregation period, the Secretary directed that additional studies be conducted, including preparation of this EIS, in order to provide the factual information needed to make a decision on a withdrawal of the area. The Secretary will determine whether it is necessary to withdraw some, all, or none of the proposed withdrawal area for up to 20 years to protect natural, cultural, and social resources in the Grand Canyon watershed from the potential adverse effects of mineral exploration and development.

1.3 PURPOSE OF AND NEED FOR ACTION

1.3.1 Purpose of Action

The Proposed Action analyzed in this document is the withdrawal of minerals in 1,006,545 acres near Grand Canyon National Park from location and entry under the Mining Law for 20 years. The underlying purpose is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the proposed withdrawal area. Consistent with Section 204(b) of FLPMA, the Department of the Interior published a notice in the Federal Register describing the proposed withdrawal application and segregating the lands proposed for withdrawal from location of new mining claims under the Mining Law for 2 years (Federal Register 74:35887) (July 21, 2009). The decision to be made by the Secretary is whether or not to withdraw, for up to 20 years, some or all of the area from location and entry under the Mining Law. This EIS analyzes impacts of the Proposed Action—i.e., the withdrawal of federal locatable mineral estate within the proposed withdrawal area—and alternatives to that action. Site-specific NEPA analyses will be conducted for all future mineral exploration or development in the proposed withdrawal, as appropriate, to examine specific impacts of specific proposed exploration or development projects.

1.3.2 Need for Action

There is a history of hardrock mining activities in the Grand Canyon watershed dating back to the 1860s. In some cases, these mining activities have left lasting impacts within the watershed, primarily associated with older copper and uranium mines (see also U.S. Geological Survey [USGS] 2010a). These historical impacts and the recent increase in the number and extent of mining claims located in the area have raised concerns that future hardrock mining activities in the Grand Canyon watershed, particularly for uranium, could result in adverse effects on resources, which include the following:

- Surface water and groundwater, including seeps, springs, wells, and runoff, that may ultimately flow into the Colorado River, which is used for agricultural, municipal, commercial, domestic, and recreational purposes by people throughout the southwestern United States;

- Cultural resources, including prehistoric and historic sites, places of traditional religious and cultural importance (including Traditional Cultural Properties or Places [TCPs]), and other places of significance to American Indians;
- Air quality and visibility in Grand Canyon National Park, a Class I airshed;
- Federally listed or proposed endangered, threatened, and candidate species; agency-listed sensitive species, conservation agreement species, and species of concern; and designated critical habitat;
- Vegetation, wildlife, and aquatic species and their habitat that are unique to the Grand Canyon watershed;
- Recreational values and opportunities for visitors to the region and for the estimated 4.4 million people who visit Grand Canyon National Park each year;
- Designated and proposed wilderness areas, areas allocated for maintenance of wilderness characteristics, and the relevant and important resources for which Areas of Critical Environmental Concern (ACECs) were designated;
- Visual resources, including night skies, scenic overlooks, and other designated scenic areas;
- Natural soundscapes, designated quiet zones, and quality-of-life values for both area residents and visitors, including intangible issues such as peace, solitude, heritage, and sense of place.

Therefore, the need for this proposed action is to address the possibility of negative impacts from hardrock mining, which is expected to increase absent a withdrawal.

1.4 ROLES, RESPONSIBILITIES, AND AUTHORITIES

This section describes the roles and responsibilities of the lead and cooperating agencies with respect to processing the proposed withdrawal and preparing this EIS. It also describes the relevant and applicable federal, state, and local laws and regulations and how they pertain to the scope of the analysis or may apply to the decisions to be made.

1.4.1 Bureau of Land Management

The BLM is the agency responsible for processing the proposed withdrawal and is the lead agency for preparing the EIS. Approximately 626,678 acres of surface managed by the BLM Arizona Strip Field Office in Saint George, Utah, are included in the proposed withdrawal, including the majority of the North and East parcels (see Figure 1.1-1). The public lands within these parcels are managed under the *Arizona Strip Field Office Record of Decision and Approved Resource Management Plan* (Arizona Strip Field Office ROD/RMP) (BLM 2008b). Locatable mineral exploration and development are managed under the current regulations at 43 Code of Federal Regulations (CFR) 3715 and 3809. In accordance with FLPMA, the Arizona Strip Field Office RMP allows for sustainable multiple uses of public lands. If a withdrawal alternative is implemented, the RMP will be updated if necessary.

The BLM follows the procedures in Section 204 of FLPMA and the regulations at 43 CFR 2300 to process withdrawals of federal lands from operation of the public land laws, including the Mining Law. Although BLM is responsible for processing the withdrawal application, the Secretary of the Interior is the decision-maker for withdrawals up to 20 years under FLPMA Section 204. Following the analysis and public commenting process conducted through the EIS process, the Secretary will issue a Record of Decision (ROD) detailing the decisions concerning the withdrawal, including the rationale for these decisions.

The BLM manages locatable mineral activity (including uranium exploration and development) in accordance with provisions of Section 302(b) of FLPMA that require the Secretary to prevent unnecessary or undue degradation of the lands from activities authorized by the Mining Law. The BLM promulgated regulations at 43 CFR 3715 and 3809 that set forth the review procedures, performance standards, and other requirements that mining claimants and operators must follow when conducting operations on public lands under the Mining Law, in order to prevent unnecessary or undue degradation.

Section 309 of FLPMA provided for the establishment of advisory councils that represent the various major interests and concerns of citizens relating to land use planning and the management of public lands within the area for which the advisory council was established. Following issuance of the temporary segregation, the BLM Arizona Resource Advisory Council (Resource Advisory Council) convened to identify key issues; outline resource data study needs; and engage the public, tribes, environmental groups, industry, state and local government, and other stakeholders. The Resource Advisory Council provided specific recommendations to BLM on issues and alternatives for the EIS process.

1.4.2 Cooperating Agencies

The Council on Environmental Quality (CEQ) regulations [40 CFR 1508.5] define a cooperating agency as any federal agency (other than the lead agency) and any state or local agency or Indian tribe with jurisdictional authority or special expertise with respect to any environmental impact involved in a proposal. Because of the size of the proposed withdrawal area and the resources potentially affected by the proposed withdrawal or alternatives, 16 agencies (federal, state, tribal, and county) with jurisdictional authority and/or applicable special expertise cooperated in the development of this EIS.

The cooperating agencies assisted with EIS preparation in a number of ways, including conducting or providing studies and inventories, reviewing baseline condition reports, identifying issues, assisting with the formulation of alternatives, and reviewing Preliminary Draft EIS text and other EIS materials. Not all of the cooperating agencies participated in all aspects of the EIS preparation. As lead agency, BLM is responsible for the content of the EIS.

Federal Cooperating Agencies

U.S. FOREST SERVICE

Approximately 321,135 acres of the Kaibab National Forest in the Tusayan Ranger District and approximately 34,739 acres of the North Kaibab Ranger District are included in the proposed withdrawal area (see Figure 1.1-1). The *Kaibab National Forest Land Management Plan, as Amended, and Record of Decision* (Kaibab LMP/ROD) (Forest Service 1988) is the presiding Kaibab National Forest management document. The Forest Service and the BLM worked closely to develop alternatives. While BLM is the lead agency for this project, the Kaibab National Forest, as a cooperating agency with jurisdictional authority, contributes vital expertise and guidance regarding the proposed withdrawal area.

The Forest Service manages locatable mineral activity (including uranium exploration and development) in accordance with provisions of the Organic Act of 1897 [16 USC 478, 551]. The Forest Service promulgated regulations at 36 CFR 228A that describe the review and approval requirements, performance standards, and other requirements that mining claimants and operators must follow when conducting operations on National Forest System lands under the Mining Law.

NATIONAL PARK SERVICE

Grand Canyon National Park has jurisdictional authority over 1.2 million acres of the Grand Canyon watershed. The proposed withdrawal area is located immediately adjacent to parts of Grand Canyon National Park both north and south of the Park boundary (see Figure 1.1-1). Although Grand Canyon National Park has no jurisdictional authority over the lands proposed for withdrawal, the National Park Service (NPS) has an affirmative responsibility under the NPS Organic Act of 1916 to ensure that activities outside Park boundaries do not adversely affect Park resources and values. Thus, NPS is a cooperating agency by virtue of its special expertise in the resources of the Grand Canyon.

The Park is already withdrawn from location and entry under the Mining Law, subject to valid existing rights; however, locatable mineral activities on adjacent (non-withdrawn) lands may have the potential to affect Park resources, such as seeps and springs, air quality, wildlife, vegetation, aquatic species, natural viewsheds, dark skies, soundscapes, important cultural resources, and recreation opportunities and settings.

The National Park Service Organic Act [16 USC 1–4] requires the NPS to conserve Park resources and the values and purposes for which the Park was established, as well as "to provide for the enjoyment" of those resources and values "in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." To fulfill these mandates, conscientious care is necessary to preserve and protect natural and cultural resources, including the primeval character of the Park backcountry, while still providing opportunities for public enjoyment of these NPS lands.

U.S. FISH AND WILDLIFE SERVICE

The U.S. Fish and Wildlife Service (USFWS) is the federal agency with jurisdictional authority concerning listed threatened and endangered, proposed, and candidate species, conservation agreement species, and critical habitat under the Endangered Species Act of 1973, as amended (ESA); bald and golden eagles under the Bald and Golden Eagle Protection Act of 1940, as amended; and migratory birds under the Migratory Bird Treaty Act of 1918 (MBTA). One of USFWS's responsibilities is to address trust species for tribes. During the EIS process, the role of USFWS is to provide input and recommendations regarding the special status species and critical habitat that could be impacted by the proposed withdrawal. In addition, as required under Section 7 of the ESA, federal agencies must consult with USFWS regarding a project's potential impacts to threatened and endangered species and critical habitat.

U.S. GEOLOGICAL SURVEY

USGS has no jurisdictional authority concerning the potential environmental impacts of the proposed withdrawal. However, USGS has special expertise in mining-related environmental conditions, mineral resource availability, geology, hydrology, and biology, and this expertise was drawn on to more fully inform this EIS process by providing baseline technical studies and engaging in consultation with the other agencies on scientific matters. To provide important foundational information for the EIS, USGS prepared Scientific Investigations Report 2010-5025, *Hydrological, Geological, and Biological Site Characterization of Breccia Pipe Uranium Deposits in Northern Arizona* (USGS 2010b).

State of Arizona Cooperating Agencies

ARIZONA GAME AND FISH DEPARTMENT

In Arizona, the Arizona Game and Fish Department (AGFD) has jurisdictional authority over fish and wildlife conservation and management, as well as public uses and recreation relating to fish and wildlife conservation and management, including off-highway vehicle (OHV) use. AGFD is tasked with conserving, enhancing, and restoring Arizona's diverse wildlife resources and habitats and therefore has special expertise with respect to Arizona's wildlife. Because the proposed withdrawal has the potential to impact fish and wildlife within Arizona, AGFD is a cooperating agency for the EIS.

ARIZONA GEOLOGICAL SURVEY

The Arizona Geological Survey's (AZGS's) charter is to serve as a primary source of geological information in Arizona to enhance public understanding of the state's geological character and mineral resources (AZGS 2010). AZGS provides technical advice and assistance in geology to other state and local governmental agencies engaged in projects in which the geological setting, character, or mineral resources of the state are involved (AZGS 2010). In addition, AZGS informs, advises, and assists the public and other agencies in matters concerning geological processes, materials, and landscapes and in the development and use of the mineral resources of Arizona. Because of its special expertise in geology, geological hazards and limitations, and mineral resources within the state, AZGS is a cooperating agency in the EIS process.

Effective July 1, 2011, Arizona SB1615, State Agencies Consolidation, transferred the duties and responsibilities of the Arizona Department of Mines and Mineral Resources (ADMMR) to the AZGS. AZGS will continue the primary objective, which is to promote the development of the mineral resources of Arizona through technical and educational processes. Other ADMMR responsibilities transferred to AZGS include providing mining, metallurgical, and other technical information and assistance to those interested in developing the mineral resources of Arizona (ADMMR 2006). AZGS provides services such as maintaining a site-specific database of unpublished reports and maps; maintaining an information bank and reference library of mineral and mining information; and producing mineral reports, annual directories, technical reports, mineral industry surveys, and information circulars. AZGS provides special expertise with respect to the development of mineral resources in Arizona and is therefore a cooperating agency in the EIS process.

ARIZONA STATE LAND DEPARTMENT

The Natural Resources Division of the Arizona State Land Department (ASLD) administers all natural resource-related leases and Conservation Districts, along with any natural resource issues affecting State Trust land. Approximately 57,617 acres of State Trust land are located within the proposed withdrawal area, mostly in the North and East parcels (ASLD 2009). While the State-owned minerals are not subject to the temporary segregation or proposed withdrawal, the withdrawal of federal minerals has the potential to influence mineral development on adjacent state lands. In addition, 4,204 acres of the federal minerals proposed for withdrawal underlie State-owned surface. Therefore, because of their special expertise regarding the resources within these lands and the state's interest in maximizing revenue from its trust lands, ASLD has been designated a cooperating agency.

Tribal Governments as Cooperating Agencies

In August 2009, the BLM and Forest Service initiated consultation via letter with the following American Indian governments regarding the proposed withdrawal: Chemehuevi Tribe, Colorado River Indian Tribes, Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Las Vegas Paiute Tribe, Moapa Band of Paiute Indians, Pahrump Band of Paiutes, Paiute Indian Tribe of Utah, Pueblo of Zuni, San Juan Southern Paiute Tribe, Navajo Nation, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe. Additional information on the consultation process is presented in Chapter 5, Consultation and Coordination.

During the consultation process, the Hualapai Tribe and Kaibab Band of Paiute Indians requested to be involved in the EIS process as cooperating agencies. The interests of these cooperators with respect to the EIS process are described below.

HUALAPAI TRIBE

The Hualapai Reservation is located west of the South Parcel. The Hualapai Tribe considers the Grand Canyon region to be of great cultural, historical, and religious significance. Lands held sacred or culturally significant to the Hualapai Tribe are not only located within the present Hualapai Reservation boundaries. Historically, the Hualapai lived in and used resources from the South Parcel and hold a substantial portion of the areas proposed for withdrawal to be culturally significant. They continue to use resources from the proposed withdrawal area today. Because of its proximity to the area and concern about impacts on its members and reservation, as well as its special expertise in the Tribe's cultural, historical and religious interest in the lands proposed for withdrawal, BLM accepted the Hualapai Tribe's request to participate as a Cooperating Agency.

KAIBAB BAND OF PAIUTE INDIANS

The Kaibab Band of Paiute Indians Reservation is located adjacent to the North Parcel proposed for withdrawal (see Figure 1.1-1), and aboriginal lands are included in all three parcels. Haul truck traffic from current uranium ore production in the North Parcel passes through the reservation and is of concern to the residents. Like the Hualapai Tribe, the Kaibab Band of Paiute Indians considers the Grand Canyon region to be of great cultural, historical, and religious significance. Because of its proximity to the area and concern about impacts on its members and reservation, as well as its special expertise in the Tribe's cultural, historical and religious interest in the lands proposed for withdrawal, BLM accepted the Kaibab Band of Paiute Indians' request to participate as a Cooperating Agency.

County Governments as Cooperating Agencies

Coconino and Mohave counties in Arizona and Kane, San Juan, and Washington counties in Utah are cooperating agencies in the EIS process. A substantial portion of the economies of these rural counties is based on both mining and recreation in the Grand Canyon region (Arizona Department of Commerce [ADOC] 2009a). The proposed withdrawal and alternatives have the potential to impact socioeconomic conditions in these counties, and the BLM invited them to participate in the EIS process as cooperating agencies.

COCONINO COUNTY, ARIZONA

The majority of the proposed withdrawal area (all of the South Parcel, all of the East Parcel, and a portion of the North Parcel) is located in Coconino County. Population in Coconino County reached over 134,000 people in 2010 (Census Bureau 2010), up from 116,320 in 2000 (Census Bureau 2000). Coconino County's commercial economy is largely tourism based accounting for a large percentage of the county's jobs and tax income.

MOHAVE COUNTY, ARIZONA

The North Parcel is partially in Mohave County. Population in Mohave County exceeded 200,000 people in 2010 (Census Bureau 2010), up from 155,032 in 2000 (Census Bureau 2000). Leading industries in the county are retail trade, tourism, construction, and health care and social services.

KANE COUNTY, UTAH

Because of its proximity to the proposed withdrawal area and its historic dependence on the Arizona Strip as a significant source of income and employment for its residents, Kane County is participating as a cooperating agency in the EIS process. Population in Kane County was 7,125 people in 2010 (Census Bureau 2010). Like Coconino County, Kane County's economy is primarily tourism based. Lake Powell, Zion National Park, and other recreation sites attract tens of thousands of visitors each year. As a result, the leisure/hospitality services sector is the leading employment sector. The mining industry is also a significant employer in Kane County. Mining wages and salaries per job have consistently been the largest in the study area and have experienced steady growth from 1980 through 2000. However, it should be noted that the number of mining jobs in Kane County has been low since at least 1980 (BLM 2008c).

SAN JUAN COUNTY, UTAH

San Juan County had an estimated population of 15,055 in 2008 (Census Bureau 2008a). One of the major employment sectors driving San Juan County's economy is mining. Denison Mines (USA) Corporation (Denison) and the recently closed Lisbon Valley Copper Mine are located in the county and have both historically, as well as recently, provided employment for county residents. The White Mesa Uranium Mill, located 6 miles south of Blanding, is used for processing uranium ore mined in the proposed withdrawal area. The proposed withdrawal or alternatives could change the amount of ore transported to the mill. Because of its economic connection with mining in the proposed withdrawal area, San Juan County is participating as a cooperating agency in the EIS process.

WASHINGTON COUNTY, UTAH

Washington County had an estimated population of 138,115 in 2010 (Census Bureau 2010). The Arizona Strip (where the North and East parcels are located) has historically been recognized as a primary source of income and employment for many of southern Utah's residents. For this reason, Washington County is a cooperating agency in the EIS process. Over the past decade, Washington County has experienced major population growth. From 1990 to 2010, the total population increased by 184.4% and is expected to continue growing. Manufacturing, wholesale and retail trade, construction, and tourism- and recreation-related services are the leading industries. Nearby Grand Canyon National Park, Zion National Park, Dixie National Forest, and Snow Canyon State Park are important recreational attractions.

GARFIELD COUNTY, UTAH

Garfield County had an estimated population of 5,172 in 2010, up from 3,980 in 1990 (Census Bureau 1990; 2008a). It is located in south central Utah, north of Kane County and west of San Juan County and includes large swaths of open desert as well as nationally designated scenic places such as Bryce Canyon National Park, Grand Staircase-Escalante National Monument, Capital Reef National Park, and a portion of Canyonlands National Park. Garfield County joined the EIS process as a cooperating agency in August 2011. The Shootaring Canyon Uranium Processing Facility (mill) is located in Garfield County near the small town of Ticaboo. The mill has been in stand-by status since 1982.

1.4.3 Authorities

A number of legal authorities apply to the processing of the proposed withdrawal application and preparation of the associated EIS. These include laws, policies, and orders that established the basic tenets of the Mining Law, set the requirements for consultation between federal agencies and tribal governments, formulated the policies on the use of federal lands, promulgated the regulations for mining on federal lands, and set overall management objectives in agency legislation. These are briefly discussed below.

Federal Laws, Statutes, and Regulations

LAWS AND STATUTES

General Mining Law of 1872

The Mining Law [30 USC 22–54] authorizes citizens to enter federal lands open to location and stake or “locate” mining claims upon discovery of a valuable mineral deposit and compliance with all other applicable statutory or regulatory requirements. A mining claim gives the claimant a possessory interest against the government and rival claimants. Mineral exploration and development conducted under the Mining Law must be performed in compliance with federal and state statutes and regulations. Additional information on the Mining Law and mining claim requirements is presented in Appendix B.

Mineral deposits that are subject to appropriation under the Mining Law are termed “locatable” and include most metallic mineral deposits, such as uranium, and certain nonmetallic and industrial minerals, such as specialty building stone. Locatable minerals do not include minerals such as coal or oil and gas, which are classified as “leasable.” Deposits of sand and gravel are termed “salable” and may be available for purchase from the land managing agency.

The ability of a claimant to locate new mining claims under the Mining Law is terminated if the lands are withdrawn from location and entry under the Mining Law. Congress can withdraw lands from operation of the Mining Law and has done so in the past (e.g., for national parks, wilderness areas, military reservations, etc.). The Secretary of the Interior can also withdraw lands from operation of the Mining Law, but as FLPMA explicitly states, the Secretary may “make, modify, extend, or revoke withdrawals but only in accordance with the provisions and limitations” of Section 204.

The Forest Service Organic Administration Act of 1897

Under the Forest Service Organic Administration Act of 1897, the Secretary of Agriculture permits access to National Forests for all lawful purposes, including prospecting for, locating, and developing mineral resources. The Organic Act remains in effect today and is one of several legal authorities directing and guiding Forest Service policy and operations, in conjunction with the Multiple-Use Mining Act of 1955, Multiple-Use Sustained-Yield Act of 1960, and NFMA.

National Park Service Organic Act of 1916

The NPS was established under the National Park Service Organic Act of 1916 [16 USC 1–4]. The Organic Act states, “The Service such established shall promote and regulate . . . to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations.”

Migratory Bird Treaty Act of 1918

The Migratory Bird Treaty Act of 1918 [16 USC 703–712, July 3, 1918, as amended 1936, 1960, 1968, 1969, 1974, 1978, 1986 and 1989] implements various treaties and conventions between the United States and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful.

Act to Establish Grand Canyon National Park, 1919

In 1919, Congress expanded and designated Grand Canyon National Monument a national park, creating Grand Canyon National Park. The Act of February 26, 1919, directed that NPS assume the responsibility for the administration, protection, and promotion of the park and authorized the NPS to grant commercial concessions "for the accommodation or entertainment of visitors" [16 USC 221 *et seq*., 40 Stat. 1175]. The Act also "reserved and withdr[ew] from settlement, occupancy, or disposal under the laws of the United States and set apart as a public park for the benefit and enjoyment of the people" land in the state of Arizona under the name of Grand Canyon National Park. The Grand Canyon National Park was withdrawn by statute from mining entry.

Bald and Golden Eagle Protection Act of 1940

The Bald and Golden Eagle Protection Act [16 USC 668–668c], was originally enacted in 1940 as the Bald Eagle Protection Act to protect bald eagles and later amended to include golden eagles. Amended several times in subsequent years, the Act prohibits anyone without a permit issued by the Secretary of the Interior from "taking" bald and golden eagles, including their parts, nests, or eggs. The definition of take includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb. Activities that can be authorized by permit include scientific collecting and research, exhibition, tribal religious uses, depredation, falconry, and the taking of inactive golden eagle nests that interfere with resource development or recovery operations. The Act provides criminal penalties for persons who violate the Act.

Surface Resources Act of 1955

The Surface Resources Act of 1955 [30 USC 611–615] did three things: 1) it expressly removed common varieties of building or construction materials from appropriation under the Mining Law; 2) it verified that unpatented mining claims could only be used for prospecting, mining, or processing operations and uses reasonably incident thereto; and 3) it subjected mining claims located after 1955 to government management and disposal of the surface resources. The Act lays the groundwork for both BLM and Forest Service surface management regulations at 43 CFR 3715 and 3809 and at 36 CFR 228A, respectively.

Multiple-Use Sustained-Yield Act of 1960

The Multiple-Use Sustained-Yield Act of 1960 provides that the purposes of the National Forest System lands include outdoor recreation, range, timber, watersheds, and fish and wildlife. While the Act supports these uses in particular, it does not directly affect the use or administration of the mineral resources on National Forest System lands.

National Historic Preservation Act of 1966

The National Historic Preservation Act of 1966 (NHPA) requires the Secretary of the Interior to maintain the National Register of Historic Places (NRHP). NHPA creates a process under which federal agencies must consider the effect of a proposed project on any property listed or eligible for listing in the NRHP before it authorizes or funds any undertaking. Section 106 of the NHPA requires federal agencies to take into account the effects of their actions on historic properties. The intent is to identify such properties, assess effects, and seek ways to avoid, minimize, or mitigate any adverse effects. The NHPA stresses the importance of active consultations with the public, Indian tribes, State Historic Preservation Offices (SHPOs), and other parties and provides the Advisory Council on Historic Preservation with the opportunity to comment on a project's potential to affect historic resources. The BLM or Forest Service review of a plan of operations for exploration or development must follow the Section 106 process in order to identify, assess, and seek ways to avoid, minimize, or mitigate any adverse effects on properties listed or eligible for listing in the NRHP.

Wilderness Act of 1964

The Wilderness Act of 1984 was passed to "establish a National Wilderness Preservation System." The Act defines wilderness as

> an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

National Environmental Policy Act of 1969

NEPA requires federal agencies to prepare an EIS prior to undertaking a major federal action that would significantly affect the quality of the human environment. NEPA also requires federal agencies to study, develop, and describe appropriate alternatives to any proposed agency action that involves unresolved conflicts concerning alternate uses of available resources. Under NEPA, agencies are required to prepare environmental documents, with input from the state and local governments, Indian tribes, the public, and other federal agencies. Because this proposed withdrawal constitutes a "major federal action," detailed analysis, agency cooperation, and public or stakeholder involvement under NEPA is required before a decision can be made.

The Department of the Interior and the BLM are preparing this EIS in accordance with NEPA, with the CEQ regulations implementing NEPA at 40 CFR 1500–1508, with Department of the Interior requirements in Department Manual 516, with Department of the Interior regulations implementing NEPA at 43 CFR 46, and with the BLM NEPA Handbook (H-1790-1) (BLM 2008a).

Mining and Minerals Policy Act of 1970

The current federal policy for minerals resource management reflected in the Mining and Minerals Policy Act of 1970, which is cited in the policy statements of FLPMA. In the Mining and Minerals Policy Act, Congress declared that it is the continuing policy of the federal government in the national interest to foster and encourage private enterprise in the following: 1) the development of economically sound and stable domestic mining, minerals, metal, and mineral reclamation industries; 2) the orderly and economic development of domestic mineral resources and reserves and reclamation of metals and minerals to help ensure satisfaction of industrial, security, and environmental needs; 3) mining, mineral, and metallurgical research, including the use and recycling of scrap to promote the wise and efficient use of our natural and reclaimable mineral resources; and 4) the study and development of methods for the disposal, control, and reclamation of mineral waste products and the reclamation of mined land, in order to lessen any adverse impact of mineral extraction and processing on the physical environment that may result from mining or mineral activities.

For the purpose of this Act, "minerals" includes all minerals and mineral fuels, including oil, gas, coal, oil shale, and uranium. The Act further requires the Secretary of the Interior to carry out this policy when exercising his or her authority under such programs as may be authorized by law other than under this section.

Clean Air Act (Extension) of 1970

The Clean Air Act of 1970, as amended (CAA), established National Ambient Air Quality Standards (NAAQS) to control air pollution. Impacts to air quality from industry, including mineral exploration and development, are controlled by mitigation measures developed on a case-by-case basis during project review. The CAA has been amended several times, most importantly in 1977 and 1990. Part C of the 1977 amendments stipulates requirements to prevent significant deterioration of air quality and, in particular, to preserve air quality in national parks, national wilderness areas, national monuments, and national seashores [42 USC 7470] by establishing federal Class I areas, including Grand Canyon, Zion, and Bryce Canyon national parks. Class I areas have more stringent controls on emission increases and protection of visibility, with a goal of no human-caused impairment. The 1990 amendment established a permit program to streamline compliance with air quality regulations into an enforceable permit for operators. The purpose of the operating permits program is to ensure compliance with all applicable requirements of the CAA and to enhance the U.S. Environmental Protection Agency's (EPA's) ability to enforce the Act.

Endangered Species Act of 1973

The general policy of the ESA, as set forth by Congress, is that "all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the Act." Section 7 of the ESA directs all federal agencies to use their existing authority to conserve threatened and endangered species and, in consultation with the USFWS or National Marine Fisheries Service (NMFS), to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7 applies to management of federal lands as well as other federal actions that may affect listed species, including the proposed withdrawal. The agencies have determined, here, that the proposed decision whether to implement a withdrawal is an action subject to consultation with the USFWS. In addition, the individual approval of a plan of operations for uranium exploration or mining is an action requiring compliance with Section 7 of the ESA, which frequently involves consultation with the USFWS or NMFS.

Grand Canyon Enlargement Act of 1975

The Grand Canyon Enlargement Act, enacted in 1975, provided for the further protection of the Grand Canyon area, doubling the size of Grand Canyon National Park to approximately 1.18 million acres (1,904 square miles). In addition, the Enlargement Act modified the deadlines for wilderness suitability review set forth in the Wilderness Act, requiring the Secretary of the Interior to report to the President, within 2 years, his recommendations regarding the suitability or non-suitability of any area within Grand Canyon National Park for preservation as wilderness [Public Law (PL) 93-620, 88 Stat. 2089]. The Act consolidated several contiguous federally owned areas, some of which already were designated as units of the National Park System, into a single national park to be administered under common administrative guidelines.

Federal Land Policy and Management Act of 1976

FLPMA establishes the BLM's multiple-use mandate to serve present and future generations. Title I, Section 102(a)(8), 43 USC 1701(a)(8), of FLPMA states that it is the policy of the United States that

> public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that,

> where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use.

Section 102(a)(10–12) states, “It is the policy of the United States that . . . public lands be managed in a manner which recognizes the Nation’s need for domestic sources of minerals . . . including implementation of the Mining and Minerals Policy Act of 1970 . . . as it pertains to the public lands.” Section 103(c) provides for a

> combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and non-renewable resources including but not limited to recreation, range, timber, minerals, watershed, wildlife and fish and natural scenic, scientific and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output.

Section 204 of FLPMA establishes the Secretary’s authority to make, modify, extend, or revoke withdrawals in accordance with the provisions and limitations of FLPMA. In concert with other applicable federal laws, statutes, and regulations, as described below, FLPMA mandates the requirements for proceeding with any proposed withdrawal. Withdrawals aggregating 5,000 acres or more are limited to 20 years’ duration.

Section 302(b) of FLPMA requires the Secretary to prevent unnecessary or undue degradation of the lands, including from activities authorized by the Mining Law. The BLM promulgated regulations at 43 CFR 3809 (3809 regulations) that detail the review, plan of operations approval, performance standards, and other requirements that mining claimants and operators must follow when conducting operations on public lands under the Mining Law in order to prevent unnecessary or undue degradation.

National Forest Management Act of 1976

The National Forest Management Act (NFMA) established the Forest Service’s management provisions in response to the population boom (and subsequent timber clear-cutting required for construction) that followed World War II. NFMA supplemented the 1897 National Forest Organic Act as the primary authority for Forest Service policy. This Act was also an amendment to the Forest and Rangeland Renewable Resources Planning Act of 1974. NFMA requires forest plans to be developed in accordance with NEPA’s procedural requirements.

Federal Water Pollution Control Act of 1972/Clean Water Act of 1977

The Federal Water Pollution Control Act of 1948 was largely amended in 1972 and further revised in 1977. With the 1977 amendments, the Act became commonly known as the Clean Water Act (CWA). The CWA, enforced by the EPA and state authorities, provides means and guidance to eliminate or reduce direct pollutant discharges into waterways and manage polluted runoff. The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation’s waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water [33 USC 1251(101)(a)]. Sections 401 and 404 of the CWA provide for permits for discharge of pollutants, or dredge or fill material, respectively, into waters of the United States and are administered by the U.S. Army Corps of Engineers (USACE).

Redwoods Act of 1978

The Redwoods Act of 1978 was an amendment to the NPS General Authorities Act of 1970. By this amendment, Congress reaffirmed the provisions of the Organic Act and made all areas of the National Park System equal in the protections afforded, no matter the individual designation. This provides equal protection to all areas of the National Park System from impairment and/or derogation of their resources: "The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established . . . directly and specifically provided by Congress."

American Indian Religious Freedom Act

The American Indian Religious Freedom Act (AIRFA) says that on and after August 11, 1978, "it shall be the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites." This law is designed to protect American Indian rights of religious freedom. It does not mandate that American Indian concerns are paramount but requires that the federal government consider such concerns in its decisions.

National Materials and Minerals Policy, Research, and Development Act of 1980

The National Materials and Minerals Policy, Research, and Development Act of 1980 specifically emphasizes the USGS's responsibility to assess the mineral resources of the nation. It also charges the Secretary of the Interior to improve availability and analysis of mineral data in federal land use decision-making [30 USC 1604(e)(3)].

Arizona Wilderness Act of 1984

The Arizona Wilderness Act of 1984, specifically Title III of the Act, designated wilderness areas within the Arizona Strip, including Kanab Creek Wilderness, Mount Logan Wilderness, Mount Trumbull Wilderness, Paria Canyon–Vermilion Cliffs Wilderness, and Saddle Mountain Wilderness. The Act "releases certain lands not designated as wilderness for such management as is determined appropriate throughout the land management planning process of the administering agency." The Act designated wilderness in furtherance of the purposes of the Wilderness Act of 1964.

Energy Policy Act of 2005

The Energy Policy Act of 2005 encourages energy efficiency and conservation; promotes alternative and renewable energy sources; reduces dependence on foreign sources of energy; increases domestic production; modernizes the electrical grid; and encourages the expansion of nuclear energy.

REGULATIONS

Title 43 Code of Federal Regulations Part 2300

These regulations set forth procedures implementing the Secretary of the Interior's authority to process federal land withdrawal applications and, where appropriate, to make, modify, or extend federal land withdrawals. The regulations contain the content and processing requirements for a withdrawal application casefile. One of the requirements for a withdrawal casefile is an environmental analysis prepared in accordance with NEPA. If a withdrawal alternative were selected, the current EIS would constitute the required NEPA analysis.

Title 43 Code of Federal Regulations Subpart 3715

The regulations at 43 CFR 3715 apply to all activities purported to be conducted under the Mining Law on BLM-administered land. The purpose of the regulations is to manage the use and occupancy of the public lands for the development of locatable mineral deposits by limiting such use or occupancy to that which is reasonably incident to prospecting, mining, or processing operations.

The regulations address the unlawful use and occupancy of unpatented mining claims for non-mining purposes, setting forth the restrictions on use and occupancy of public lands open to the operation of the mining laws in order to limit use and occupancy to those reasonably incidental uses. The rule establishes procedures for beginning occupancy, standards for reasonably incidental use or occupancy, prohibited acts, procedures for inspection and enforcement, and procedures for managing existing uses and occupancies. It also provides for penalties and appeals procedures. The rule is used to prevent unnecessary or undue degradation of the public lands from uses and occupancies not reasonably incident to mining. The rule does not adversely affect bona fide mining operations or alter BLM’s regulations in 43 CFR 3800 pertaining to them.

Title 43 Code of Federal Regulations Subpart 3809

The regulations at 43 CFR 3809 apply to exploration and development activity for locatable minerals, including uranium, on BLM-managed lands. The regulations were developed to implement Section 302(b) of FLPMA, which requires the Secretary to prevent unnecessary or undue degradation of the lands, including from activities authorized by the Mining Law. The “3809 regulations” underwent major revision in November 2000 and again in October 2001. The regulations detail the review, plan of operations approval, performance standards, reclamation requirements, financial guarantee, and enforcement provisions that mining claimants and operators must follow when conducting exploration and mining. Because the 3809 regulations have a key role in the protection of the Grand Canyon watershed from the potential adverse effects of uranium mining, they are discussed briefly in Chapter 2 and Appendix B of this EIS.

Title 36 Code of Federal Regulations Part 228 Subpart A

The regulations at 36 CFR Part 228 Subpart A (228A regulations) apply to all prospecting, exploration, and mining operations, whether within or outside the boundaries of a mining claim, authorized under the Mining Law and conducted on National Forest System lands, including the lands in the proposed withdrawal area. These regulations were originally promulgated in 1974 as 36 CFR 252 and were based on the Forest Service’s authority under the Organic Administration Act of 1897. In 1981, the rules were redesignated 36 CFR 228A. In 2005, a final rule clarifying when a plan of operations is required [36 CFR 228.4A] also was adopted. However, the regulations have not been significantly revised since 1974. The regulations detail the review, approval, performance standards, reclamation requirements, financial guarantee, and enforcement provisions that mining claimants and operators must follow when conducting mining operations, including uranium mining operations. Because the 228A regulations have a key role in the protection of the Grand Canyon watershed from the potential adverse effects of uranium mining, they are discussed briefly in Chapter 2 and Appendix B of this EIS.

EXECUTIVE ORDERS

Executive Order 12898 of 1994, Environmental Justice

Executive Order (EO) 12898 says that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. To address environmental justice requires federal agencies to ensure that proposed projects under their jurisdictions do not cause a disproportionate environmental impact that would affect any group of people owing to a lack of political or economic strength on the part of that affected group. Each federal agency shall conduct the programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. The Department of the Interior, in coordination with the Working Group established by the EO, and, after consultation with tribal leaders, shall coordinate steps to be taken pursuant to this order that address federally recognized Indian tribes.

With regard to the proposed withdrawal, low-income populations and minority populations will be identified and their participation sought in the EIS process. The EIS will analyze the potential effects of the proposed withdrawal and alternatives and identify low-income populations and minority populations that may disproportionately be subject to the project benefits and risks. The requirements of EO 12898 also apply when BLM or the Forest Service reviews a site-specific plan of operations for uranium exploration or development.

Executive Order 13007 of 1996, Sacred Sites

EO 13007 limits the meaning of “sacred site” to a “specific, discrete, narrowly delineated location on Federal land” that a tribe, or an authoritative tribal religious practitioner, has identified as sacred by virtue of its established religious significance or ceremonial use. Where such sites have been identified, EO 13007 says that in managing federal lands, each executive branch agency with statutory or administrative responsibility for such management shall, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, do the following: 1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners; and 2) avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies shall maintain the confidentiality of sacred sites.

Table 1.4-1 lists the above laws and regulations, as well as other relevant authorities.

Table 1.4-1. Federal Laws, Statutes, Regulations, Executive Orders, and Presidential Proclamations

Federal Laws and Statutes
Act to Establish Grand Canyon National Park, 1919
American Indian Religious Freedom Act of 1978 [PL 95-341; 42 USC 1996]
Archaeological and Historic Data Preservation Act of 1974 [PL 86-253, as amended by PL 93291; 16 USC 469]
Archaeological Resources Protection Act of 1979 [PL 96-95; 16 USC 470aa–mm]
Arizona Wilderness Act of 1984 [PL 98-406]
Bald and Golden Eagle Protection Act
Clean Air Act of 1990 [as amended by PL 92-574; 42 USC 4901]
Endangered Species Act of 1973 [PL 85-624; 16 USC 661, 664, 1008]

Table 1.4-1. Federal Laws, Statutes, Regulations, Executive Orders, and Presidential Proclamations (Continued)

Federal Laws and Statutes, continued
Energy Policy Act of 1992
Energy Policy Act of 2005 [PL 109-59]
Federal Land Policy and Management Act of 1976, Section 201(a) [PL 94-579; 43 USC 1701 *et seq*.]
Federal Water Pollution Control Act (CWA) of 1972 [33 USC 1251]
Forest Service Organic Administration Act of 1897 [16 USC 475]
Grand Canyon Enlargement Act of 1975
Hazardous Materials Transportation Act of 1975
Historic Sites Act of 1935 [PL 292-74; 16 USC 461–467]
Migratory Bird Treaty Act of 1918 [16 USC 703–712, as amended]
Mining Law of 1872 [30 USC 21-42]
Mining and Minerals Policy Act of 1970 [30 USC 21a]
Multiple-Use Mining Act of 1955
Multiple-Use Sustained-Yield Act of 1960 [16 USC 528-31]
National Environmental Policy Act of 1969 [PL 91-190; 42 USC 4321]
National Materials and Minerals Policy, Research and Development Act of 1980
National Historic Preservation Act of 1966 [PL 89-665; 16 USC 407(f)]
National Park Service Organic Act of 1916
Native American Graves Protection and Repatriation Act of 1990 [PL 101-601]
National Forest Management Act of 1976
National Materials and Minerals Policy, Research and Development Act of 1980
Nuclear Waste Policy Act of 1974
Redwoods Act of 1978
Safe Drinking Water Act of 1982
Surface Resources Act of 1955
Uranium Mill Tailings Radiation Control Act of 1978
Wilderness Act of 1964 [PL 88-577; 16 USC 1131 *et seq*.]
Executive Orders
EO 11514, Protection and Enhancement of Environmental Quality
EO 11593, Protection and Enhancement of the Cultural Environment
EO 11988, Floodplain Management [43 CFR 6030]
EO 11990, Wetland Protection
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
EO 13007, Indian Sacred Sites
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds
EO 13175, Tribal Consultation
EO 13212, Actions to Expedite Energy-Related Projects
EO 13287, Preserve America
Federal Regulations
40 CFR 1500–1508, CEQ implementation of NEPA
43 CFR 2300, Land Withdrawals
33 CFR 320–331 and 40 CFR 230, Section 404 of the CWA and Its Implementing Regulations
43 CFR 46, Department of the Interior, Implementation of NEPA
36 CFR 220, Forest Service NEPA Procedures
36 CFR 228, Minerals

Table 1.4-1. Federal Laws, Statutes, Regulations, Executive Orders, and Presidential Proclamations (Continued)

Federal Regulations, continued
36 CFR 800, as amended, Protection of Historic Properties
43 CFR 2800, as amended, Rights-of-Way Principles and Procedures 43 CFR 3715, Use and Occupancy Under the Mining Laws
43 CFR 3809, Mining Claims under the Mining Law: Surface Management
50 CFR Parts 10, 14, 20, and 21, USFWS Implementation of MBTA
50 CFR 400, USFWS Implementation of ESA

State Laws and Regulations

Table 1.4-2 lists state laws and regulations applicable to uranium mining and the proposed withdrawal.

Table 1.4-2. Arizona State Laws and Regulations

State Regulations
Arizona Revised Statutes (ARS) 27, Minerals, Oil and Gas
ARS 17, Game and Fish
ARS 30, Power
ARS 40, Public Utilities and Carriers
ARS 45, Waters
ARS 48, Special Taxing Districts
ARS 27–151, AZGS
ARS 28, OHVs
ARS 37, Public Lands
ARS 41, State Government
ARS 49, The Environment
Arizona Administrative Code 12, Natural Resources, Chapter 5
Arizona Native Plant Law
ADMMR Special Report 12, *Laws and Regulations Governing Mineral Rights in Arizona*
ADMMR Special Report 23, *Manual for Determination of Status and Ownership, Arizona Mineral and Water Rights*

1.4.4 Relationship to Existing Land Use Plans

Bureau of Land Management Arizona Strip Field Office ROD/RMP

The proposed withdrawal would occur on 626,678 acres managed under the Arizona Strip Field Office ROD/RMP (BLM 2008b). Although the proposed withdrawal and alternatives are not specifically mentioned in the ROD/RMP, they would be consistent with the plan's objectives, goals, and decisions. Section 1.4.1 above discusses the BLM's planning authorities as they relate to the proposed withdrawal.

Kaibab National Forest Land and Resource Management Plan/ROD

The proposed withdrawal would occur on 355,874 acres managed under the *Kaibab National Forest Land and Resource Management Plan, as Amended, and Record of Decision* (Forest Service 1988). The Plan notes that the Kaibab Plateau portion of the Forest, as part of the Grand Canyon National Game Preserve, had previously been withdrawn from mineral entry. Certain special areas such as designated Wilderness and developed recreation sites are also closed to mineral entry and location. Other portions of the Forest have hitherto been open to mineral entry, but under "intensive management . . . to protect surface resource and other environmental values." No portion of the Plan precludes future withdrawals. Section 1.4.2 above discusses the Forest Service's planning authorities as they relate to the proposed withdrawal.

Tribal Plans and Policies

Although the proposed withdrawal area is not within their respective tribal jurisdictions, the Navajo, Hualapai, Havasupai, and Hopi each consider all or parts of the proposed withdrawal area as ancestral homelands. Proposed withdrawal would be consistent with tribal plans and policies on tribal lands adjacent to the proposed withdrawal area. Uranium exploration and development activities that would occur under any of alternatives, as described in Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios, would be contrary to tribal goals and policies, as described below.

In 2005, the 20th Navajo Nation Council enacted the Diné Natural Resources Protection Act with the purpose of ensuring that no further damage occur to the "culture, society, and economy of the Navajo Nation because of uranium mining" and that "no further damage to the culture, society, and economy of the Navajo Nation occurs because of uranium processing until all adverse economic, environmental and human health effects from past uranium mining and processing have been eliminated or substantially reduced to the satisfaction of the Navajo Nation Council." The Act banning uranium mining applies to the entirety of Navajo Nation land, which spans three states (Navajo Nation 2005).

The Hualapai Tribal Council also renewed a ban on uranium mining on 1 million acres of reservation land in 2009 (World Information Service on Energy Uranium Project 2009). The Havasupai and Hopi Tribes have enacted similar resolutions banning uranium mining on reservation lands.

County and Local Plans

A large portion of the proposed withdrawal would occur in Coconino County, Arizona. Mineral withdrawal proposals are not included in the *Coconino County Comprehensive Plan* (Coconino County 2003). In this plan, the County has outlined goals for water resources to "protect, preserve, and improve the quality of surface water and groundwater." The plan also discusses community character objectives for tribal lands and interests, historic and cultural resources, scenic vistas and viewsheds, scenic corridors, dark skies, and natural quiet. The plan acknowledges, "Mining has never had a significant impact on Coconino County. However, many mining claims could be reactivated if markets for certain minerals—such as uranium—improve." Coconino County Board of Supervisors passed a resolution opposing uranium mining in proximity of the Grand Canyon National Park and its watersheds (Resolution No. 2008-09). The resolution requested a moratorium on the mineral leasing of State Trust lands and a permanent congressional withdrawal of the Tusayan Ranger District and House Rock Valley (the South and East parcels).

The proposed withdrawal would also take place in Mohave County, Arizona. Mineral withdrawal proposals are not included in the *Mohave County General Plan* (Mohave County 2008). The General Plan's Natural Resource Goals and Policy 5.1 states the County "should consider determinations made by the State Land Department, the BLM and other Federal agencies to identify and protect sensitive lands (wetlands, sensitive habitats and other valuable natural resources)." Mohave County passed Resolution 2009-040 on February 5, 2009. The resolution urges Congress to preserve access to the uranium reserves of northern Arizona in order to meet America's demand for clean non-carbon emitting energy and energy independence (Mohave County 2009). The proposed withdrawal is inconsistent with County Resolution 2009-040.

Consistency with Kane County's General Plan is not considered here as the proposed withdrawal area is not within the jurisdiction of Kane County, Utah. However, proposed withdrawal scenarios that would occur under any of the action alternatives, as described in Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios, would be contrary to county Resolution 2008-10 (passed on May 12, 2008). The resolution says the county supports multiple uses on public lands in general and lists uranium mining as one of the uses that should continue (Kane County 2008). The proposed withdrawal is inconsistent with County Resolution 2008-10.

Consistency with the general plans of Washington, Garfield, and San Juan Counties is also not considered for the same reasons as above. However, during the period between the Draft and Final EIS, all four southern Utah counties and Mohave County in Arizona formed the AZ/UT Coalition of Coordinating Counties. That body passed a unanimous resolution on April 18, 2011 opposing the proposed withdrawal. The proposed withdrawal is inconsistent with that resolution.

The Town of Tusayan was incorporated in Arizona in April 2010. The South Parcel includes lands that occur within the Tusayan General Plan. The Tusayan General Plan adopts all Coconino County codes and plans. Section 12–Industrial Zones states that mineral extraction operations require a conditional use permit (Town of Tusayan 2010).

See sections 3.16 and 4.16 for detailed discussion on local area communities.

1.5 IDENTIFICATION OF ISSUES

1.5.1 Process

Publication of the Notice of Intent (NOI) in the *Federal Register* on August 26, 2009, initiated the formal scoping process. The scoping comment period concluded on October 30, 2009. During the scoping period, BLM hosted two public meetings; the first was held on September 30 in Fredonia, Arizona, the second on October 15 in Flagstaff, Arizona. Pursuant to NEPA requirements, the scoping meetings were advertised in a variety of formats (*Federal Register*, news media, BLM website, and by mail), beginning at least 2 weeks prior to their scheduled dates. In each format, the advertisements provided logistics and explained the purpose of the public meetings, gave the schedule for the public scoping period, outlined additional ways to comment, and provided methods for obtaining additional information.

The public meetings were conducted in an open house format designed for attendees to view informational displays, ask specialists about the Proposed Action and the EIS process, and submit written or verbal comments. Meeting attendees signed in upon entering, at which time they were provided with handouts and informed of the meeting format and how to comment. The handouts and displays provided information about the following:

- NEPA process,
- proposed withdrawal background,
- proposed withdrawal schedule,
- preliminary issues to be analyzed in the EIS,
- proposed withdrawal location, and
- how to provide comments.

The public was afforded several methods for providing comments during the scoping period:

- Comments could be recorded on comment forms at the scoping meetings. Comment forms were provided to all meeting attendees and were also available throughout the meeting room, where attendees could write and submit comments during the meeting.
- Emailed comments could be sent to a dedicated email address: azasminerals@blm.gov.
- Individual letters and comment forms could be mailed via U.S. Postal Service to Bureau of Land Management, Mineral Withdrawal EIS, 345 East Riverside Drive, St. George, UT 84790.

What Is an Issue?

Issues are usually expressed in terms of actual or perceived effects, risks, or hazards that a particular land or resource use may have on other lands or resources that are used or valued for other purposes.

During the scoping process, a number of issues were identified by the public, by BLM, and by cooperating agency managers and resource specialists. The Resource Advisory Council provided recommendations on issues and alternatives to consider.

One purpose of scoping is to provide an opportunity for members of the public to learn about the proposed withdrawal and to share any concerns or comments they may have. Input from the scoping process is then used to identify issues and concerns to be considered in the EIS. In addition, the scoping process helps identify potential alternatives to the Proposed Action as well as issues that are not considered significant and that can therefore be eliminated from detailed analysis in the EIS. The list of stakeholders and other interested parties is also updated and generally expanded during the scoping process.

The BLM received a total of 83,525 individual comment submittals during the public scoping period from 90 countries. Approximately 97% of these submittals consisted of 15 different form letters; other submittals included emails, BLM-furnished comment forms, and letters and faxes. Comments obtained during the scoping period were used to define the relevant (i.e., significant) issues that would be addressed in the EIS, as well as to assist in development of the alternatives. Scoping comments were analyzed and placed in one of two categories: 1) issues identified for analysis in the EIS (see Section 1.5.2); and 2) issues eliminated from detailed analysis because they are beyond the scope of the EIS (see Section 1.5.3).

1.5.2 Issues for Analysis

Substantive issues and concerns expressed during the agency and public scoping period were grouped by topic in the following categories:

- Air quality/climate
- American Indian resources
- Cultural resources
- Wilderness
- Mineral resources
- Public health and safety
- Recreation
- Social conditions
- Economic conditions
- Soil resources
- Soundscapes
- Special status species
- Vegetation resources
- Visual resources
- Water resources
- Fish and wildlife resources

Issue statements were then developed that describe the relevant issues identified during scoping to be analyzed in the EIS. The issues are described below in Table 1.5-1 and follow the general organization of EIS Chapters 3 and 4. Issues include those raised by agencies, the general public, interest groups and businesses, and the Resource Advisory Council. The issues represent topics for analysis, not conclusions regarding environmental effects.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis

Resource Category/ Issue	Description of Relevant Issue
Air Quality and Climate	
Release of particulates	The release of particulates (dust) from exploration drilling operations, mining, and ore hauling traffic and other vehicles on unpaved roads could have an effect on the regional air quality. This could occur in combination with pre-existing emissions from coal plants, cities, traffic, and other sources of regional air pollution to create a cumulative regional effect on air quality.
Increase in regional haze	Increase in regional haze emissions from all exploration and development activity and equipment could contribute to the regional haze affecting air quality in the study area, as well as affect overall scenic quality.
Geology and Mineral Resources	
Change in underground geological conditions	Mining of uranium deposits would alter conditions underground, which could allow uranium and other minerals to be mobilized, entering the groundwater system. It has also been suggested that mining uranium deposits could remove a potential source of long-term contamination.
Availability of mineral resources	Providing a domestic source of mineral resources is one of the legitimate uses of public lands. Restrictions or closures individually and cumulatively decrease this ability, and substantial energy potential would be unavailable if the proposed withdrawal is put into effect.
Depletion of uranium resources	Mining these uranium deposits in the near future will deplete domestic resources that may be needed later for energy production or national security purposes.
Water Resources	
Dewatering of shallow perched aquifers	Mining of some uranium deposits would penetrate near-surface aquifers and could dewater them. The resulting water loss could affect nearby springs or shallow water developments.
Surface runoff from active or reclaimed mines	Surface runoff from active or reclaimed mine sites could contain elevated uranium and other metals, which would affect downstream water quality.
Contamination of deep regional aquifers by metals leached from mined ore deposits	Mining of uranium ore deposits could change the flow of groundwater and increase the leaching of metals into the deep groundwater aquifers (e.g., Redwall Limestone). This leaching could occur both during mining and after mine closure and could affect downgradient water quality. There are scientific uncertainties associated with understanding the hydrogeology and connections between groundwater and surface water systems, as well as how potential contamination in those systems would travel. The potential to contaminate water in the Grand Canyon region, including seeps and springs, thereby impacting water quality and biotic communities at discharge points, is an issue.
Contamination or loss of the Tusayan municipal water supply	The potential for the Tusayan municipal water supply to be affected by nearby uranium exploration or development activity is an issue.
Contamination of municipal water supplies derived from the Colorado River	The potential for elevated uranium and other metals, in either surface water or groundwater, to enter the Colorado River and contaminate the major downstream municipalities' primary source of drinking water in several western states is an issue.
Soil Resources	
Disturbance of soil resources	Soil resources in the area are valuable and could be difficult to re-establish once disturbed by exploration and development.
Loss of soil productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil productivity, creating potential short-term, long-term, and cumulative environmental impacts on soils and overall watershed function.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis (Continued)

Resource Category/ Issue	Description of Relevant Issue
Vegetation Resources	
Disturbance of vegetation	Vegetation in the area could be difficult to re-establish once disturbed by exploration and development. Riparian vegetation could be affected by changes in groundwater conditions.
Vegetation productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil cover and vegetation productivity.
Special status species (Vegetation)	The potential short-term, long-term, and cumulative environmental impacts of uranium exploration and development on threatened, endangered, proposed, candidate, and sensitive species and their critical habitat are an issue. For vegetation species, these are usually direct impacts tied to surface disturbance; for species that rely on groundwater in the area, springs and seeps are significant.
Fish and Wildlife Resources	
Wildlife habitat	Issues associated with wildlife habitat include fragmentation of habitat by construction of new roads and transportation of uranium ore, noise from exploration or development activities that disrupts wildlife, wildlife disturbed by visual instructions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species. Uranium mining could affect groundwater resources through groundwater contamination or depletion at springs, caves, seeps, and creeks; this in turn could affect species associated with these areas. Aboveground deposits on soils, plants, and surface water can expose a variety of biota to chemical and radiation exposure.
Wildlife populations	The potential loss of critical wildlife winter range and the potential for activity to occur in critical calving or fawning areas or to disrupt nesting habitat, etc., are an issue.
Wildlife mortality	The increase in vehicle traffic associated with increased uranium exploration and development or increased recreational use on new roads could cause increased vehicle/wildlife accidents and associated wildlife mortality.
Special status species (wildlife)	The potential short-term, long-term, and cumulative environmental impacts of uranium exploration and development on threatened, endangered, proposed, candidate, and sensitive species and their critical habitat are an issue. For wildlife, these issues are usually indirect impacts associated with disturbance of habitat, loss of habitat, and contamination of habitat (including aquatic habitat), such as effects on area springs and seeps, increased noise, and increased traffic.
Visual Resources	
Changes in regional visual quality	Exploration and development activity would release pollutants, which could increase regional haze (see Air Quality issue) and result in changes in visibility that could affect the scenic quality of the region.
Visual intrusion to Park visitors	Exploration and development activity may be visible to Park visitors, either from key observation points within the Park or from areas in the backcountry of the Park. This could detract from visitors' experiences.
Visual intrusion to public outside the Park	Exploration and development activity may be visible to the public, either from key observation points or from areas in the backcountry. This could detract from visitors' experiences. The potential short-term, long-term, and cumulative impacts from mineral exploration and development activities on the area's visual quality and recreation use patterns are an issue. There could be a conflict between mineral exploration and development activities and Visual Resource Management classes.
Soundscape	
Noise disruption from exploration or development activity	Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park. The areas subject to noise effects and the intensity of sound from these activities need to be evaluated.
Cultural Resources	
Disturbance of historic and prehistoric sites	Surface disturbance associated with exploration or development activity could expose and cause damage to archaeological sites. Visual and atmospheric changes could adversely affect the integrity of site settings and cultural landscapes. It may not be possible to mitigate all adverse effects through scientific data recovery.
Effect on TCPs	Surface disturbance associated with exploration or development activity could disrupt the setting or integrity of TCPs such as the Red Butte area on the Tusayan Ranger District or other TCPs located in or near the parcels.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis (Continued)

Resource Category/ Issue	Description of Relevant Issue
American Indian Resources	
Disturbance of traditional cultural practices and uses	Mineral exploration and development activity could affect the integrity of religiously and culturally significant sites and landscapes and could disrupt traditional practices and uses. Such practices include ceremonial activities, gathering of plants or other natural resources, and use of springs and trails. Tribes have expressed concerns about potential disturbance and contamination of culturally important resources.
Protection of tribal trust resources or assets	Tribal trust resources and assets are property, or property rights or interests, actually owned by a tribe. These may include property or rights located on- or off-reservation. As a trustee for the tribes, the federal government has the responsibility to preserve and protect tribal trust resources and assets from loss or degradation. One trust resource issue is the potential contamination of Havasupai Springs and the economic impact of reduced tourism for the Havasupai Tribe if the springs were to be contaminated.
Wilderness	
Wilderness Areas	Designated wilderness is already withdrawn. However, mining adjacent to Wilderness Areas could affect the wilderness characteristics of these lands, including lands managed as wilderness in Grand Canyon National Park.
Recreation	
Roads and access	Development of roads for mineral exploration and development could both facilitate access for some recreation users and provide too much public access in areas currently used for more primitive recreation. Uranium exploration and development in the area may create conflicts between tourism and mining-associated development and traffic.
Primitive recreation opportunity	Changes in amount of mineral exploration and development activity would change visual and auditory conditions, which in turn could affect primitive recreation opportunities in the area. The potential for water contamination and impacts to area seeps and springs, as well as recreation users, including river runners, backpackers, and hikers in the Park, is an issue.
Social Conditions	
Population trends	There could be changes in population levels associated with decreased mineral exploration and development activity under a withdrawal. Likewise, the continued mineral development in the absence of a withdrawal could involve local population increases, as additional workers are required. Increases in population increase the demands on local infrastructure such as schools, roads, and emergency services. Decreases in populations, while decreasing the demand for such services, can also reduce revenue available to support services.
Road condition, maintenance, and safety	The total number of ore truck trips that would be required for mineral exploration and development activity would affect the region's resources. The use of road systems to service mine operations requires increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access. Mineral exploration and development activity could provide funding from property and use taxes for maintenance needs. Decreases in activity mean less maintenance along with less potential revenue. The increased traffic volumes, roadway use conflicts between haul trucks, local residents, and visitors to the region, and highway safety concerns are an issue.
Public health effects	The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport. There are concerns about the potential short-term, long-term, and cumulative environmental impacts of uranium exploration and development activity, including toxic waste hazards, on human health. Potential human health impacts that could accompany mining and any resulting accumulation of uranium in water, soils, and airborne particulate matter in the Grand Canyon region and in the Colorado River and its tributaries are an issue.
Environmental justice	The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. Environmental justice is the equitable distribution of project benefits and risks with respect to low-income populations and minority populations. In the case of uranium mining, it is the distribution of the project benefits, primarily economic, compared with the distribution of the project impacts such as pollution or risk of pollution, that is the issue.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis (Continued)

Resource Category/ Issue	Description of Relevant Issue
Economic Conditions	
Energy resources available	The withdrawal could lead to increased reliance on energy sources other than nuclear, such as additional mining elsewhere, imports of uranium from foreign sources, or production from equivalent amounts of other sources like coal, petroleum, natural gas, wind power, or solar.
Effects on economic activity from tourism	Tourism represents a large component of the economic activity for many communities in the region and for the state. The manner and degree to which continued mining could change the nature and quality of the natural resources that attract tourism are an issue. Specifically, the potential for uranium exploration, development, and haulage to disrupt visitor experiences could impact the regional tourist economy. The regional tourism economy is connected to the Grand Canyon in terms of jobs, annual revenues, and tax revenues across different tourism sectors.
Economic activity from mineral development	Mineral resources and the benefits associated with mineral extraction would be foregone or potentially foregone should the proposed withdrawal go into effect. Mineral exploration and development activity represents a large component of the economic activity for many communities in the region. The manner and degree of the proposed withdrawal could directly affect the economic activity in the area, particularly in smaller communities.

1.5.3 Issues Eliminated from Detailed Analysis

Issues beyond the scope of the EIS include issues not directly related to decisions to be made regarding the proposed withdrawal and issues that are not relevant to the purpose of and need for action. Also, issues more properly considered at a different level of analysis or by a different entity have been eliminated from detailed analysis.

The following issues have been eliminated from detailed analysis because they are beyond the scope of the EIS:

- Revision of the Mining Law.
    - Revision of the Mining Law of 1872 is out of the scope of the decision to be made in this EIS; any changes to the law would require Congressional action.
- The assertion that mining companies have been allowed to exploit public lands without giving the American people a fair return for their use (i.e., charging a royalty on mine production).
    - Charging or changing royalties on mineral production is out of the scope of the decision to be made in this EIS; any change to royalties and taxes would require Congressional action.
- Illegal activities such as poaching, vandalism, and unauthorized collection of cultural artifacts, or unauthorized OHV travel; these are law enforcement issues.
    - Illegal activities, as mentioned, are law enforcement issues and not relevant to the decision to be made in this EIS. This EIS studies the impact of withdrawing lands from the Mining Law and illegal activities that may occur within the proposed withdrawal area are not considered as an impact in that action.
- Acid deposition or acid rain from power generation and its effects on flora or fauna.
    - This EIS studies the impacts of withdrawing lands from the Mining Law. Acid deposition of acid rain from power generation is unrelated to the impacts of withdrawal and the decision to be made.

- Analysis of specific alternative energy sources (e.g., wind or solar) to employ and where to employ them as substitutes for uranium resources made unavailable if lands in the area were to be withdrawn.
  - Alternative energy sources have no relevance to the decision to withdrawal lands from the Mining Law. The EIS does not analyze uranium as an energy source.
- The role of nuclear energy in the nation's energy future.
  - Analysis of the nuclear energy industry is outside of the scope of the decision to be made in this EIS. This EIS analyzes the impacts of withdrawing lands from the Mining Law. There is no way to determine what the uranium ore extracted from the withdrawal area, once processed, would be used for and where it in the world it might end up.
- The amount by which the use or non-use for energy production of uranium found in the proposed withdrawal area could change global temperatures.
  - Analysis of energy production from uranium extracted from the proposed withdrawal area is outside of the scope of the decision to be made. The decision to be made is on withdrawal of lands from the Mining Law. In addition, it would be impossible to determine how the uranium extracted from the withdrawal area is used, after processing. Processed uranium is sold on the open market and used for a variety of purposes, beyond energy production.
- The extent to which uranium energy production offsets the use of carbon-based fuels that contribute to the release of greenhouse gases (GHGs), which have been linked to global climate change.
  - This is outside of the scope of the decision, as stated above. However, this EIS does analyze the Proposed Action's impacts on GHGs in Section 4.2, Air Quality and Climate.
- National defense use of uranium.
  - This is outside of the scope of the decision, as stated above.
- Disposal of spent nuclear fuel.
  - This is outside of the scope of the decision, as stated above.
- Alternate locations besides the White Mesa Mill in Blanding, Utah, in which mined uranium should or should not be processed, stored, or sold.
  - It is assumed in this EIS that uranium ore in the region will continue to be processed at the White Mesa Mill in Blanding, Utah, because the quantity of uranium ore determined in the Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios (see Appendix B) can be met by current milling capacity.

1.5.4 Changes from Draft to Final

Most changes made to the EIS were editorial or clarified the EIS in response to public comments. However, in response to public comment and to correct errors discovered after release of the DEIS, the sections discussed below did undergo some changes beyond those of an editorial or clarifying nature. As explained further below, BLM did not substantially alter the Proposed Action or any of the alternatives in a way that is relevant to environmental concerns. In addition, none of the information relied upon in support of these changes constitutes significant new information relevant to environmental concerns and bearing on the proposed action or its impacts. Therefore, supplementation of the DEIS is not required under CEQ regulations at 40 CFR 1502.9(c). None of the comments resulted in a substantial alteration to the Proposed Action and, to the extent any of them relied on new information, that information was not sufficient to show that the Proposed Action would affect the quality of the human environment to a significant extent not already considered.

Withdrawal Area Boundaries

Adjustments were made to the North and South Parcel boundaries to correct for mapping errors found subsequent to the DEIS. The North Parcel was adjusted to remove portions of the already-withdrawn Kanab Creek Wilderness from the proposed withdrawal, as well as to add a 1-mile-wide rectangular parcel in the extreme southeast corner that had mistakenly not been included in the DEIS description of the proposed withdrawal. Overall, North Parcel acreage changed from 554,124 to 549,995 acres. The South Parcel was adjusted by removing four small, separate parcels from the proposed withdrawal (one along the western boundary, two along the southern boundary and one along the eastern boundary.) In addition, updated data representing the federal mineral estate on the South Parcel resulted in a total decrease of 102 acres from the DEIS to the FEIS. There were no changes to the East Parcel boundary. The changes in the boundary are minor and do not constitute a substantial change to the proposed action; nor do they result in significant changes to the environmental impacts.

Air Quality

Adjustments were made to the North and South Parcel's total number of haul trips under each of the Alternatives. These adjustments were made to correct errors found subsequent to the DEIS to account for underestimation of the number of haul trips associated with the existing mines. These adjustments resulted from changes made to the RFD; these changes were based on information provided by commenters that modified the amount of uranium expected to be extracted from the four mines with approved plans of operation. The total numbers of haul trips originating from the North Parcel were adjusted from 208,385 to 221,298 for Alternative A; 86,065 to 98,978 for Alternative B; 119,425 to 132,338 for Alternative C; and 197,265 to 210,178 for Alternative D. The total numbers of haul trips originating from the South Parcel were adjusted from 69,540 to 73,967 for Alternative A; 2,820 to 7,247 for Alternative B; 36,180 to 40,607 for Alternative C; and 47,300 to 51,727 for Alternative D. The total numbers of haul trips originating from the East Parcel were not adjusted as there are no existing mines. The resultant increase in pollutant emissions was calculated based on those adjustments. Overall, the adjustments resulted in increases in pollutant emissions under all of the Alternatives. The changes were necessary to account for changes in the RFD. No changes were made to the proposed action as result of these adjustments. In addition, there was no new information resulting in these changes; rather, there were errors made in the calculation. These adjustments also do not result in significant changes to the Air Quality impact analysis.

Vegetation, Fish and Wildlife, and Special Status Species

The BLM Sensitive Species list was updated from the BLM 2005 and 2008 special status species lists used in the DEIS to the BLM January 2011 special status species list. The January 2011 species list removed several species and added several new species to include in the analysis. The updated species list includes three new birds, five new mammals, two new amphibians, four new plants, and the removal of four mammal and three plant species. Available information regarding these species does not indicate the Proposed Action would have significant impacts not already analyzed in the DEIS. The physical characteristics, habitats, and behaviors of these species are not significantly different from the species analyzed in the DEIS and any impacts to these newly listed species from the Proposed Action are anticipated to be similarly beneficial (USFWS 2011). Thus, new information in the 2011 special status species list did not show that the proposed withdrawal would have impacts on special status species to a significant extent not already considered in the DEIS.

Cultural Resources

The Cultural Resources analysis (Sections 3.11 and 4.11) was updated to reflect adjustments made in the proposed withdrawal boundary. The overall number of sites in the North Parcel was adjusted from 743 to 623 sites. No change in the numbers of sites in the East and South parcels was necessary. The changes in the boundary are minor and do not constitute a substantial change to the proposed action; nor do they result in significant changes to impacts to cultural resources.

Wilderness and Wilderness Characteristics

The discussion of wilderness characteristics in the DEIS was removed from the wilderness resources section and moved to its own section in the FEIS based on BLM Instructional Memo (IM) 2003-275. Internal scoping on the DEIS recommended that wilderness characteristics be included as a separate section of the FEIS. In addition, public comments on the DEIS that questioned how the proposed withdrawal is consistent with the purposes of the Arizona Wilderness Act of 1984 warranted additional discussion. The nature of the potential impact to wilderness resources did not change.

Recreation

Due to the proposed withdrawal boundary revision, individual and total acreages of the route network and Recreation Opportunity Spectrum were revised in the FEIS. This revision was necessary for an accurate analysis of the potential effects to recreation resources. The boundary change from the DEIS to the FEIS removes certain ROS acreages from the withdrawal parcels. Thus, a minor change in the nature of potential direct impacts to primitive and unconfined recreation settings within the proposed withdrawal parcels has resulted. The changes in the boundary are minor do not constitute a substantial change to the proposed action; nor do they result in significant changes to impacts on recreation.

Social Conditions

Due to numerous public comments on the DEIS, an adjustment to the social conditions study area was made between the DEIS and FEIS; in the DEIS, the study area included five counties (Coconino and Mohave Counties in Arizona and Kane, San Juan, and Washington Counties in Utah); communities and counties within 50 miles of the proposed withdrawal parcels were described. For the FEIS, the study area was revised to include Garfield County.

For the demographics and economic conditions discussion in the FEIS, the six-county study area was further divided into two portions (north and south) to recognize the natural and economic barrier that results from the presence of the Grand Canyon and to better define demographic and economic impacts by location. Additionally, the FEIS now focuses on the communities in close proximity to the withdrawal areas or to the mill in Blanding, Utah, and are therefore the most likely to be affected by the withdrawal scenarios; these include Colorado City, Fredonia, Bitter Springs CDP, Page, and Tusayan CDP in Arizona and Kanab and Blanding in Utah. This was not based on any significant new information. Instead, the changes were made to better focus the social conditions impacts analysis on the counties most likely to be affected.

Finally, in response to public comments on the DEIS, the environmental justice analysis was revised in two primary ways. First, if the minority or low-income population statistics for a given community did not exceed 50%, the DEIS used each county that a community was located in as a reference area to identify the presence of an environmental justice community. For this analysis, based on guidance and methodologies recommended in the federal CEQ's Environmental Justice Guidance under the National Environmental Policy Act (December 1997), a low-income population exists where either the low-income population of the affected area exceeds 50% or the low-income population percentage of the affected area is meaningfully greater than the low-income population percentage in the general population or other appropriate unit of geographic analysis. For instance, in the DEIS the communities in Coconino County were compared to the minority and low-income (below poverty level) statistics for the county as a whole. For the FEIS, the states (Arizona and Utah) were used as a reference area to identify the presence of an environmental justice community, if the minority or low-income statistic was lower than 50%. Second, the DEIS analysis (Section 4.15) concluded that impacts to environmental justice communities would be the same for non-environmental justice communities, and therefore they would not be disproportionately impacted. As a result of public comment on the DEIS and additional interagency consultation, the assumption that impacts to environmental justice communities would be the same for non-environmental justice communities was not used in the revised FEIS analysis; the communities identified to be environmental justice communities (see 3.16.1) located closest to the proposed withdrawal area were identified to be the most likely to experience a disproportionate impact. There would be no environmental justice impacts under Alternatives B and C; however, Alternatives A and D could result in minor, long-term disproportionate health impacts to environmental justice communities. To the extent this is new information, because the impacts do not rise to the level of significance, these changes do not warrant supplementation. That is, there were no significant impacts identified not already considered in the DEIS.

Economics

Section 4.17, Economic Conditions, has been revised to respond to comments addressing the economic and fiscal impacts of mining activity under each alternative. These changes are summarized below and are also addressed in detail in the responses to public comments table in Chapter 5. The revised economic impact methodology is discussed in greater detail in Section 4.17. Although the revised analysis resulting from public comments corrected assumptions underlying the economic impacts of the proposed withdrawal under each of the alternatives, including the No Action (Alternative A), as explained further below, the FEIS comparisons and conclusions are not markedly different from those presented in the DEIS.

Both the description of the affected environment for economics and the economic effects analysis in the DEIS (Section 3.16 and Section 4.16 of that document) were the subject of many comments. While some of these comments focused on relatively minor issues in terms of presentation or interpretation, other comments substantively focused on the analysis of the economic and fiscal benefits of mining activity under each alternative.

After review, BLM determined that it needed to revise the economic analysis in the DEIS to address two issues. First, the direct job impacts analysis underestimated the number of direct job-years per mine. In particular, that analysis was based on direct jobs *per phase* of mining operations; however, the direct jobs calculation failed to recognize that most mining phases span more than one year. This resulted in an underestimate of the number of direct jobs per mine, and, since indirect and induced jobs were based on the number of direct jobs, also resulted in an underestimation of those types of jobs.

Second, when the DEIS used the IMPLAN model to calculate the impacts of mining under each alternative on output, value-added, and fiscal conditions, it allocated the jobs for each alternative to various sectors outside the mining sector (specifically, consulting services and mining support sectors) in the model instead of allocating these jobs only to the mining sector. The allocation of these jobs to sectors outside the mining sector contributed to inconsistencies between the RFD’s total value of production per year and that estimated by the DEIS’s use of the IMPLAN model, as well as overestimation of the value-added and fiscal impact estimates for each alternative. As a result, the economic impact analysis was revised and appears in Section 4.17 of this document. The largest differences in the analysis of the economic benefits of mining are in terms of direct and total mining-related jobs – where the FEIS estimates are higher than those of the DEIS, 536 total annual jobs for

Alternative A in the FEIS versus 332 in the DEIS. The differences between estimates in the FEIS versus DEIS in the other metrics (e.g. output, value-added and fiscal conditions) are much smaller. This is because both the DEIS and FEIS account for the multi-year phases of mining operations when calculating output, value-added, and fiscal conditions.

Although the baseline discussion of economics in chapter 3 and the analysis of economic effects in chapter 4 have changed, the changes do not result in a significant difference in impacts reported for the Proposed Action or any analyzed alternatives than that reported in the DEIS. The revised methodology produces economic impact estimates that are consistent with both the assumptions made in the RFD (upon which the analysis of environmental consequences is based) concerning total uranium production under each alternative and its value, and the assumptions provided by industry concerning the number of jobs needed per mine, by phase of mining activity. The DEIS and the FEIS both applied consistent methods in estimating the economic impacts of mining for each alternative. Consequently, the relative economic impacts of the alternatives (e.g. the ratios of estimated economic activity between the various alternatives) are similar in both analyses. Much of the data used in the FEIS is not new, but rather is being applied in ways that correct errors from the DEIS. Any new information included in the FEIS provides a more accurate, localized analysis than that conducted in the DEIS.

Other refinements to the economic analysis are:

1. Dividing the study area into two pieces (north and south) to recognize the natural and economic barrier that results from the presence of the Grand Canyon and to better define economic impacts by location.
2. Moving away from the use of national tourism impact ratios to estimate the size of the tourism-related economy and instead using published information from National Park Service-funded studies concerning the economic impacts of the specific National Parks, National Monuments and National Recreation Areas in the study area.
3. More explicitly recognizing key uncertainties, limitations and unknowns in the economic effects analysis.

Supplementation is not required as a result of these changes. First, the more explicit recognition of uncertainties, limitations and unknowns is not based on new information at all; rather, these revisions were made in response to comments and make the document more clear with regard to those issues. In other words, there was no change in the analysis relating to environmental concerns; rather, these revisions more explicitly acknowledge the uncertainty existing in that analysis. Similarly, dividing the study area into two pieces was not based on significant new information. Instead, BLM acknowledged comments that the two areas are different economically and therefore decided to discuss them separately to provide greater ability for comparison of economic impacts in each area. This revision simply provides more specificity and context with regard to economic impacts in each area.

In addition, the change from using national tourism-impact ratios to using site-specific data is not based on new information relevant to environmental concerns. Indeed, this refinement did not result in a change to the impacts analysis as both the DEIS and FEIS acknowledge that available information indicates that there would be no more than minor effects to tourism under any of the alternatives. Instead, this discussion is informational and to provide context regarding the economic impacts from mining under each alternative.

Finally, the correction of the number of mining jobs and the modified utilization of the IMPLAN model are not based on new information but rather revise the way existing information is used. That is, the revisions to the analysis to (1) acknowledge that many phases of mining operations span multiple years and (2) modify the use of the IMPLAN model with regard to allocation of mining jobs, do not rely on new information regarding those issues; instead, they simply revise two aspects of the methodology with respect to how jobs and economic impacts are calculated.

To the extent this is considered to be new information or circumstances, it is not significant and not relevant to environmental concerns or impacts. The environmental impacts of the alternatives are based on the RFD, and, as noted above, these changes make the economic impact analysis consistent with the RFD's estimates regarding economic output of each mine. Since the RFD did not change, there was no change to the EIS's analysis of environmental impacts as a result of these revisions. Moreover, as noted above, the revisions did not result in significant differences in the relative economic impacts of each alternative between the DEIS and FEIS. The ratio of total jobs for a particular alternative compared to total jobs under the no action alternative (Alternative A) is similar as between the DEIS and FEIS. Thus, any new information related to the impacts on mining jobs and allocation of those jobs in the IMPLAN model does not result in environmental impacts of the proposed action to a significant extent not already considered.

Reasonably Foreseeable Development Scenarios (Appendix B)

The RFD discussion was changed to better reflect that commodity prices were not expected to be stable, but rather that commodity prices were expected to stay at or higher than a level that would support continued uranium mining.

Based on comments regarding the estimate of uranium quantity, the methodology was changed for estimating the amount of uranium present in the four mines with approved plans of operation. In the DEIS, the amount of uranium estimated to be present in these four mines was based on reserve estimates published in regulatory filings. However, commenters provided historical data demonstrating that published reserve estimates are consistently substantially lower than the amount actually mined. On average, the amount of uranium actually mined is 2.57 times greater than the amount originally estimated solely from surface drilling. Incorporating this change resulted in an increase of the amount of uranium expected to be mined from each location by a factor of 2.57. This change only affected the four mines with approved plans of operation; the average amount of uranium associated with mines not yet developed or discovered was already based on the actual amounts of uranium historically mined instead of reserve estimates from surface drilling. This change primarily affected calculations in the Geology Sections (3.3 and 4.3) and the estimated number of haul trips needed as cited in Chapter 2, Alternatives, and a number of other resource-specific sections of the FEIS. Because the amount of uranium associated with mines with approved plans of operation represents only a portion of the total amount of uranium available within the withdrawal area, the total estimated uranium reserves themselves did not change by the same factor. The increase in mined uranium ranged from 16% under Alternative A to 61% under Alternative B. The impact conclusions relative to haul trips were not altered as a result of these changes. Thus, there was no new information (significant or otherwise) relevant to environmental concerns. Any new information related to the amount of uranium actually mined relates only to the four mines that are projected to be mined under all withdrawal alternatives and thus does not change the basis for comparison between the alternatives. As noted, it also did not change the impact conclusions from the resulting increase in haul trips. It therefore does not result in environmental impacts of the proposed action to a significant extent not already considered.

Chapter 2

PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

Chapter 2 describes in detail the proposed withdrawal (Proposed Action) and alternatives to the Proposed Action. Section 2.2 explains how the issues identified during scoping were used to develop alternatives. Section 2.3 describes the alternatives that were considered but eliminated from detailed analysis. In Section 2.4, each alternative is presented in detail in three segments: 1) an explanation of what lands would be withdrawn from location under the Mining Law, 2) the operating requirements for locatable mineral exploration and development, and 3) the level of reasonably foreseeable future locatable mineral operations that could occur under that alternative based on the reasonably foreseeable development (RFD) scenarios (see Appendix B). Section 2.5 describes past, present, and reasonably foreseeable future actions that may contribute to cumulative impacts. The identification of a preferred alternative is discussed in Section 2.6. Comparison tables are presented in Sections 2.7 and 2.8 to summarize and contrast the major provisions and impacts of each alternative. Legal descriptions of the parcels proposed for withdrawal under each action alternative (Alternatives B, C, and D) are provided as Appendix C.

NEPA and its implementing regulations promulgated by the CEQ require that an agency rigorously explore and objectively evaluate all reasonable alternatives. Reasonable alternatives are those that meet the purpose of and need for action and that are feasible to implement, taking into consideration regulatory, technical, economic, environmental, and other factors. In addition to reasonable alternatives, the EIS must also analyze the No Action Alternative, which provides a baseline against which to compare the potential environmental impacts for the action alternatives.

Alternatives are the heart of the EIS, as they present other possible courses of action that could achieve the underlying purpose of and need for action to which the agency is responding. In this case, as described in Chapter 1, the underlying purpose of and need for action is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of locatable mineral exploration and development that could occur in the area.

In response to the above-stated purpose and need, approximately 1 million acres have been proposed for up to a 20-year withdrawal in order to prevent the location and development of new mining claims. This chapter of the EIS explores other options to the Proposed Action in the form of alternatives that could be used to address the purpose and need, as well as the No Action Alternative. How the Proposed Action and alternatives achieve the underlying purpose of and need for action is assessed by the decision-maker based in part on the environmental effects of each alternative, which are described in detail in Chapter 4 and summarized in Table 2.8-1. This comparative analysis of alternatives is done to provide the decision-maker, as well as the public, with a clear picture of the distinctions between the alternatives from the standpoint of environmental effects, which contributes to providing a clear basis for making an informed choice between alternatives.

2.2 DEVELOPMENT OF ALTERNATIVES

As detailed in Section 1.5, two public meetings were held to identify issues and assist with alternatives development. The formal public scoping process began on August 26, 2009, with the *Federal Register* publication of an NOI to prepare an EIS for a proposed withdrawal. By the end of the formal scoping period, the BLM had received a total of 83,525 comment submittals.

The alternative development process began with evaluating the public input collected during scoping and continued with extensive discussion between the BLM, as the lead agency, and the cooperating agencies, including the Forest Service, NPS, USFWS, and USGS; tribal governments; and state and local governments; recommendations were also sought from the Resource Advisory Council. The main issues identified during scoping were in the categories of Air Quality, Cultural Resources, Public Health and Safety, Recreation and Visuals, Socioeconomics, Soil and Water Resources, Special Status Species, Transportation, and Wildlife. These preliminary concerns were grouped into five categories in order to seek specific input from agency resource specialists: Biological Resources (vegetation, wildlife), Cultural Resources, Hydrologic Resources (including groundwater, surface water, and soils/erosion potential), Recreation/Visuals, and Socioeconomics. Alternatives were developed by superimposing the above categories of resource values on a single map in order to identify where such resource values were concentrated and hence outline the areas that were most sensitive to surface disturbance activities such as might occur during locatable mineral exploration and development.

In formulating alternatives to the proposed withdrawal, the BLM and cooperating agency managers and scientists—as a group and as separate resource-specific teams—initially decided on several general parameters that could be changed in order to develop a range of reasonable alternatives that would meet the purpose of and need for action, minimize impacts to resources, and address the key concerns identified in scoping. The parameters initially used were as follows:

- The proposed withdrawal area boundaries could be reduced to focus on those areas with a high concentration of sensitive resources or areas with limited data on sensitive resources.
- The proposed withdrawal area boundaries could be changed based on the uranium potential within the parcels, i.e., to include or exclude high-potential lands.
- The environmental protection requirements and other management programs in the proposed withdrawal area could be changed, possibly eliminating the need for the proposed withdrawal.
- The time frame of the proposed withdrawal could be decreased; for example, the withdrawal could be limited to 10 years instead of 20 years.

In addition, the necessity that all alternatives must be reasonable and meet the purpose of and need for action as defined in Chapter 1 (Section 1.3) was emphasized to all personnel involved in the alternative development process.

The initial suggestions for alternatives were subjected to a formal screening process to determine which were or were not viable, that is, which types of alternatives would meet the purpose of and need for action, would eliminate or minimize potential impacts, and would be distinct enough from other alternatives to provide a range of reasonable alternatives for the decision-maker. Suggestions such as phasing mining, limiting the number of mines that could operate at any given time, changing the Mining Law, and others, were screened out as parameters. The alternatives screened out and the rationale for not considering them are included in Section 2.3, Alternatives Considered But Eliminated from Detailed Analysis.

As a result of this process, four alternatives have been developed for detailed analysis to address the significant relevant issues identified during scoping. Note that the preferred alternative, which has been selected and is being identified in this Final EIS, could have been any one of the alternatives presented in the Draft EIS, or some combination or minor variation of the alternatives presented (see Section 2.6).

- **Alternative A**, the No Action Alternative: the proposed withdrawal would not be implemented and the proposed withdrawal area would remain open to location and entry under the Mining Law. New mining claims could be located and exploration and development activities would continue to be processed by the BLM or the Forest Service. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations. This alternative serves as the baseline for measuring the impacts of the three action alternatives (Alternatives B, C, and D) and reflects the current management situation for all federal lands within the area proposed for withdrawal.

- **Alternative B**, the Proposed Action and Preferred Alternative: the proposed withdrawal would be implemented and the entire 1,006,545 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. New exploration and mine development proposals could continue to be authorized by the BLM or the Forest Service only on mining claims where valid existing rights are determined to exist, in accordance with applicable laws. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.
- **Alternative C**, Partial Withdrawal: 648,805 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw the largest contiguous area identified on the resource overlays with concentrations of cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development (see also Figures 2.4-2 through 2.4-4 in Section 2.4.4). Within the portions selected for withdrawal, new exploration and mine development proposals could continue to be authorized by the BLM or the Forest Service only on mining claims where valid existing rights are determined to exist, in accordance with applicable laws. Alternative C would leave the remaining portions of the proposed withdrawal area with isolated or low concentrations of these resources open to operation of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.
- **Alternative D**, Partial Withdrawal: 292,088 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw the contiguous area identified on the resources overlays where there is a high concentration of cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development (see also Figures 2.4-5 through 2.4-7 in Section 2.4.5). Within the portions selected for withdrawal, new exploration and mine development proposals could continue to be authorized by the BLM or the Forest Service only on mining claims where valid existing rights are determined to exist, in accordance with applicable laws. Alternative D would leave the remaining portions of the proposed withdrawal area with isolated or low concentrations of these resources open to operation of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

One of the purposes of alternatives is to address relevant significant issues identified scoping. Each of the above alternatives was prepared to address certain issues raised during scoping or to meet requirements for alternatives analysis contained in regulation and policy, as explained below.

Alternative A is the No Action Alternative as required by NEPA [40 CFR 1502.14(d)]. The No Action Alternative "provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives" (CEQ 1981:Question 3). Alternative A provides the environmental baseline against which the other alternatives are compared.

Alternative A would continue to rely upon the existing requirements and programs to protect the resources in the Grand Canyon watershed without the proposed withdrawal. It addresses the comments and concerns raised during scoping whether the existing regulations applicable to exploration and development are adequate to protect the resources in the Grand Canyon watershed and that the withdrawal would unnecessarily restrict mining and result in economic impacts to local communities that are counting on mining to support their economies. Alternative A addresses the identified concern that uranium production needs to be maintained or allowed to expand as a low-carbon energy source to meet the nation's clean energy needs.

Alternative B, the Proposed Action and the Preferred Alternative, is the Secretary's proposal to withdraw 1,006,545 acres of federal locatable mineral estate, subject to valid existing rights. As the Proposed Action, it is the federal action whose environmental consequences are considered in this EIS. This alternative addresses the issues and concerns raised during scoping over the natural resource and human health and safety impacts that could be associated with increased uranium mining in the Grand Canyon watershed and the potential impacts of mining on tourism, recreational uses, American Indian tribes, and cultural resource values.

Alternatives C and D are partial withdrawal alternatives designed as geospatial approaches to balance the socioeconomic impacts of a complete withdrawal (particularly the potential loss of economic benefits associated with uranium exploration and development in the area) and the protection of the areas that contain concentrations of biological, cultural, ethnographic, hydrologic, recreational, and visual resources. These alternatives focus the withdrawal preventing the location of new mining claims on areas with concentrations of nonmineral natural resources yet leave some high-potential uranium lands available for development.

To arrive at the partial withdrawal areas shown for Alternatives C and D, resource specialists and scientists from the federal agencies attended several alternatives discussion and development workshops. During the workshops, resource specialists considered the purpose of and need for action, to protect the natural, cultural, and social resources in the Grand Canyon watershed in order to identify the geographic areas of highest resource occurrence. The geographic areas from each group of resource specialists were then superimposed to determine the areas where such resources were concentrated in order to formulate the withdrawal boundaries of Alternatives C and D.

Representatives from the state, tribal, and county cooperating agencies were consulted during the development of the alternatives and invited to provide input. In addition, the Resource Advisory Council was asked to provide recommendations on issues and alternatives to be considered.

More detailed descriptions of Alternatives A through D are provided in Section 2.4, below. Section 2.7, Comparison of Alternatives, includes summary tables that identify key components, acreages, and reasonably foreseeable future mining-related activities by alternative for each parcel.

2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

Sometimes, alternatives are suggested or proposed that on closer examination do not adequately respond to the purpose of and need for action, are technically or economically infeasible, are not ripe for consideration because they are remote or speculative, are substantially similar in design to an existing alternative, or would have substantially similar effects as an existing alternative. In such cases, the alternatives are usually eliminated from detailed analysis. Alternatives to the proposed withdrawal that were considered and eliminated from detailed analysis are described below, along with the rationale for their elimination.

2.3.1 Change in Duration of Withdrawal

An alternative was initially considered to change the time frame of the proposed withdrawal from 20 years to 10 years, or even to 5 years. However, it was determined a shorter term withdrawal does not warrant evaluation as a separate alternative because withdrawals can be renewed by the Secretary of the Interior, provided that the underlying reason for the withdrawal is still valid. Since protection of the Grand Canyon watershed is a long-term need and mining interest is foreseeable in the long term, it is quite possible that a shorter term withdrawal would simply be renewed, resulting in no meaningful difference between a 10-year and a 20-year withdrawal. Therefore, an alternative that consisted solely of changing the duration of the proposed withdrawal was eliminated from further detailed analysis.

2.3.2 Withdraw Only Lands with Low Mineral Potential

It was suggested early in scoping that a partial withdrawal of only the lands with low mineral resource potential be considered for withdrawal. Such an alternative was suggested as a possible means to leave the high-potential lands available for mineral development, with a withdrawal to remove other lands with high nonmineral natural resource values from location and entry under the Mining Law.

This alternative was eliminated from detailed analysis for several reasons. All the lands in the proposed withdrawal area are rated as having a high potential for uranium resources, lying within what USGS terms Favorable Area A (USGS 2010b). While certain specific areas within the proposed withdrawal area have attracted greater industry interest than others (the North and South parcels in particular), all of the lands involved in the proposed withdrawal are considered to be lands with some of the highest uranium potential in the country. Another factor affecting the feasibility of this alternative is that much of the uranium exploration and development activity to date tends to coincide with many of the areas that have the highest concentration of nonmineral resource values. This is evident when comparing the active and existing mines shown on the figures in this chapter with the areas depicted as having high concentrations of nonmineral resources. This coincidence suggests that mineral potential, or mineral development interest, would not be a useful discriminating factor in designing a partial withdrawal alternative that would meet the purpose of and need for action.

2.3.3 No Withdrawal—Phased Mine Development

This alternative was considered as a way to limit the level of exploration and development activity in place of a withdrawal. Under this alternative, potential impacts to resources in the Grand Canyon watershed would be protected by limiting mineral development to certain areas at certain times, with a limited amount of mineral exploration and development activity occurring at any one time. This “phased development” alternative was eliminated from detailed analysis because it does not address the relevant aspect of the mining issue—the location of the activity—and the effects from specific individual mines on area resources. The RFD scenarios described in Appendix B do not indicate the likelihood of multiple mines’ overlapping in time or location and creating such extensive cumulative impacts that phased development would be a particularly useful mitigation approach.

Alternatives that better address the issue of impacts from the development of multiple mines either prohibit new mining in areas with sensitive resources under one of the withdrawal alternatives or include careful screening for cumulative impacts under the existing regulations. Therefore, the phased mine development alternative, as a separate alternative, was eliminated from further analysis.

2.3.4 Permanent Withdrawal

During scoping, it was suggested that a permanent withdrawal be implemented instead of the proposed withdrawal for 20 years. The rationale for this is that if Grand Canyon resources require protection from the potential adverse effects of mining, that protection should be for longer than 20 years.

This alternative was considered but eliminated from detailed analysis for several reasons. A permanent withdrawal would require congressional action because the Secretary does not have the ability to implement a withdrawal for more than 20 years for areas aggregating more than 5,000 acres [FLPMA Section 204(c)], In addition, Congress is already considering just such a proposal under the legislative process [HR 855], which is the appropriate venue for such an action. Furthermore, it is unclear whether there would be much difference between how a permanent withdrawal addresses the relevant significant issue of effects from uranium mining in the Grand Canyon watershed, compared with the proposed 20-year withdrawal. Withdrawals made by the Secretary under the authority of FLPMA are renewable as long as the underlying reason for the withdrawal is still valid. Hence, the environmental consequences of a permanent withdrawal and a 20-year withdrawal with respect to uranium mining could be difficult to distinguish in a separate alternative.

2.3.5 Change the Mining Law

Many comments received in response to the Notice of Proposed Withdrawal and during scoping suggested that reforming or changing the Mining Law would address potential environmental impacts to the Grand Canyon watershed. While the Mining Law is fundamentally a law for acquiring property rights, rather than an environmental law, presumably the comments were directed at eliminating the ability to establish property rights and increasing agency discretion to prevent mining. This alternative was eliminated from consideration for several reasons.

Making or amending law is an explicit function of the Congress, and proposals to change the Mining Law are currently under consideration before Congress. Even if such a change in law could be structured that responded to the purpose of and need for action with respect to mining in the Grand Canyon watershed, it is unlikely to be implemented in time to have any effect before the emergency withdrawal expires and new mining claims can be located. Because an alternative to amend the Mining Law is too speculative, may not address the purpose and need, and is not within the ability of the Secretary to implement, it has been eliminated from detailed analysis.

2.3.6 New Mining Requirements

During scoping, it was suggested by members of the public and the Resource Advisory Council that instead of the withdrawal, the BLM and Forest Service should consider new locatable mineral exploration and development requirements, along with certain program initiatives, to protect the resources in the Grand Canyon watershed from the potential adverse effects of uranium exploration and development. During alternative formulation, the interagency team identified a number of potential new requirements for uranium exploration and development within the area proposed for withdrawal. Such requirements included processing and review requirements specific to notices and plans of operation, as well as regional monitoring programs, remediation efforts, targeted research initiatives, and coordinated interagency oversight, including the following:

- The BLM and Forest Service would require a plan of operations for all activity exceeding casual use in the area. Surface disturbance exceeding casual use, including exploratory drilling, could not be conducted under a notice but would require a plan of operations and be subject to NEPA analysis and the opportunity for public comment.
- The BLM and Forest Service would not approve a plan of operations in which the environmental analysis determines that substantial irreparable harm would occur to significant natural or cultural resources in the Grand Canyon watershed that could not be effectively mitigated. This requirement would be used where the plan of operations was considered unreasonable because it posed a substantial risk of causing impacts that would result in the permanent loss of significant values and irreplaceable resources that could not be mitigated using available technology.

- Before approving a plan of operations, the BLM or Forest Service would consult with the NPS on the operating and reclamation standards needed to prevent the impairment of Grand Canyon National Park System resources. Such measures would be incorporated into the BLM or Forest Service decision as conditions of approval when determined necessary to protect National Park System resources.
- The BLM and Forest Service would assess civil penalties, when necessary, in order to enforce their respective operating requirements.
- A compensatory off-site mitigation program would be established that could be used for regional mitigation at legacy uranium mine sites that require cleanup, or for responding to unanticipated events or conditions at mine operations that are found to be adversely affecting natural, cultural, or social resources in the Grand Canyon watershed.
- A cost recovery program would be used to fund federal agency monitoring and compliance activities determined necessary to oversee individual mining operations.
- The BLM and Forest Service would undertake an initiative, in conjunction with other federal and state agencies, to establish regional programs to monitor wildlife indicator species for effects resulting from uranium mining.
- The BLM and Forest Service would undertake an initiative, in conjunction with other federal and state agencies, to establish regional programs to identify, characterize, and monitor area groundwater and spring conditions for effects associated with uranium mining.
- The BLM and Forest Service would undertake an initiative, in conjunction with other federal agencies and tribal governments, to establish regional programs to identify and monitor other natural and cultural resources for effects associated with uranium mining.
- The BLM and Forest Service would establish a standing regional interagency workgroup to advise the federal land managing agencies on monitoring, research needs, and operating and reclamation performance standards.

Most of the requirements described above would require changing the BLM and Forest Service surface management regulations at 43 CFR 3809 and 36 CFR 228A, respectively, in order to be implemented. The rulemaking process for amending regulations can take years, and the final outcome is not certain until a final rule is published. Furthermore, changing the regulatory requirements could be proposed as a subsequent action in conjunction with any of the withdrawal alternatives, including the No Action Alternative. The other program requirements or initiatives listed above could be implemented under any alternative independent of a withdrawal action or a regulation change. Because a New Mining Requirements Alternative would depend on the outcome of some future regulatory process yet to be initiated, its ability to be implemented is speculative, and a separate alternative considering such measures and their effectiveness has been eliminated from detailed analysis.

2.4 DESCRIPTION OF THE ALTERNATIVES

This section describes the elements of each alternative in sufficient detail to understand what would be involved in its implementation. The individual alternative description is divided into three components: 1) a description of the area that would be withdrawn from location and entry under the Mining Law with accompanying maps as appropriate; 2) a narrative that describes the operating requirements for locatable mineral exploration and development activities; and 3) the reasonably foreseeable future activity or actions that could occur based on the RFD scenario developed for each alternative, as detailed in Appendix B.

The first component, the description of area to be withdrawn, focuses on Alternatives B, C, and D. There is no withdrawal associated with Alternative A, since Alternative A is the No Action Alternative. The second component, the narrative describing the operating requirements for locatable mineral exploration and development activities, is essentially the same for Alternatives A through D. Requirements for mining companies to comply with environmental regulations administered by other federal and state agencies would also apply to all alternatives. Many of these compliance requirements are expressed as project design features intended to reduce or minimize environmental impacts. Some aspects of the requirements, such as the procedures for determining valid existing rights, are especially relevant to the alternatives that include a withdrawal since new activity would be limited to those claims with valid existing rights as of the date of the segregation, July 21, 2009.

The reasonably foreseeable future activity, the final component described under each alternative, focuses on key outputs from Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios. The RFD scenarios were prepared in order to provide a broad overview of the types and amount of reasonably foreseeable future locatable mineral exploration and development. As an overview, the RFD scenarios do not replace the detailed review required at the project level, nor are they substitutes for the validity examinations required to assess valid existing rights under the Mining Law. Instead, the RFD scenarios provide a consistent set of assumptions regarding anticipated exploration or development that could occur under each alternative and serve as the basis for assessing the environmental effects in Chapter 4.

Predictions of reasonably foreseeable future locatable mineral exploration, development, and mining activities are presented for each alternative and include estimates of the following:

- Number of mines,
- Amount of exploration activity,
- Miles of new mine access roads,
- Miles of power lines,
- Number of ore haul trips,
- Acreage of surface disturbance, and
- Water use.

These numbers from the RFD scenarios should not be regarded as absolute, meaning they are only estimates of what could occur under each alternative using a consistent set of assumptions. Their main utility is for comparing the alternatives. The RFD numbers do not constitute a limit or minimum on the level of future locatable mineral operations.

The acreages of areas withdrawn, operating requirements, and RFD projections for each alternative are summarized at the end of this chapter in Tables 2.7-1 through 2.7-3, respectively.

2.4.1 Past Withdrawals

Discrete areas in the region have already been withdrawn, or made unavailable, to entry and location under the Mining Law. These previously withdrawn lands, illustrated in Figure 2.4-1 and listed in Table 2.4-1, would remain withdrawn under all of the alternatives. In addition, several tribes in the region, including the Havasupai Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe, and Kaibab Band of Paiute Indians, have declared a uranium mining moratorium for their tribal lands.

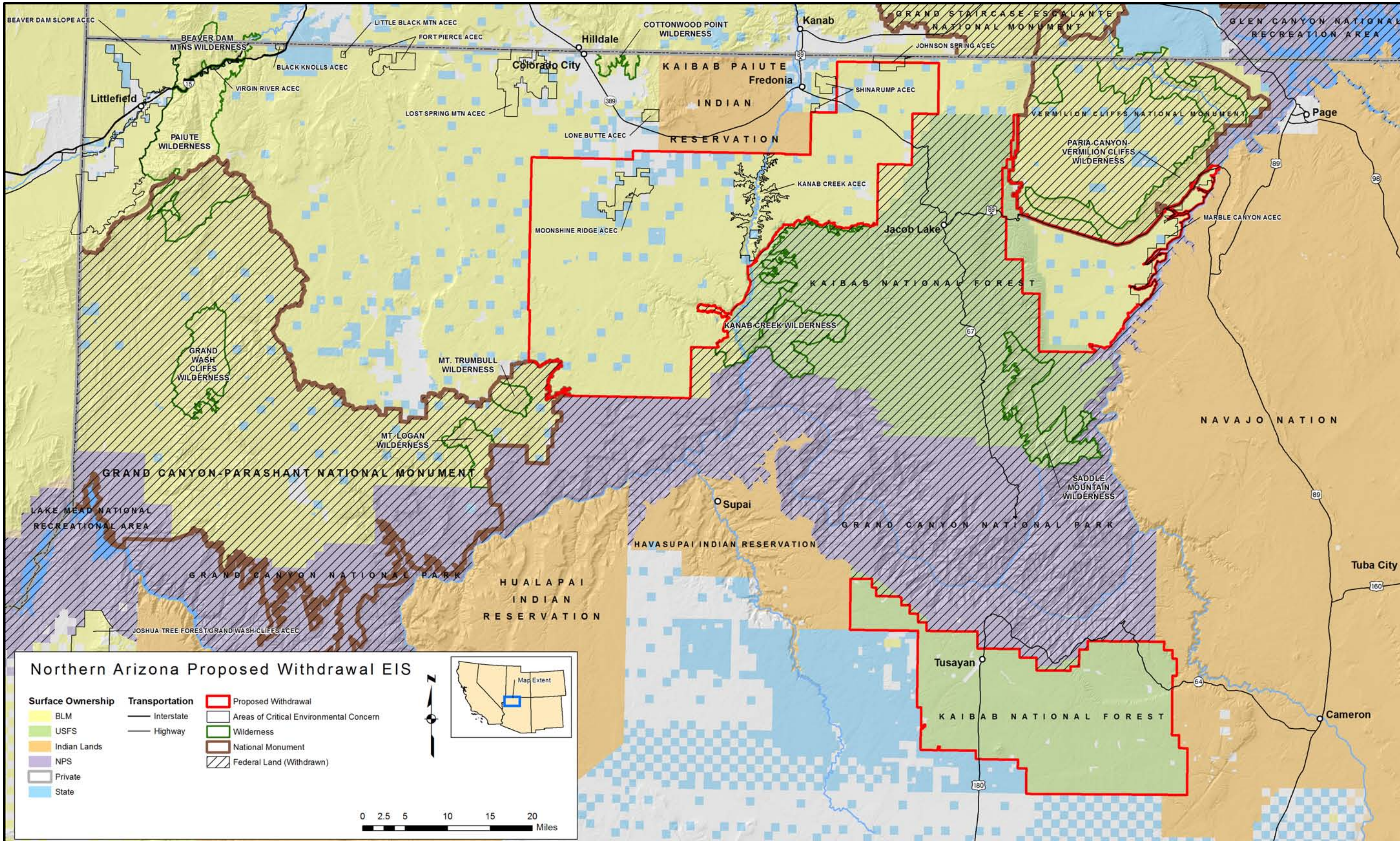


Figure 2.4-1. Previously withdrawn lands in the proposed withdrawal region.

Table 2.4-1. Lands in the Vicinity of the Proposed Withdrawal Area Previously Withdrawn from Mining Activity

Withdrawn Land Designation	Surface Area (square miles)	Acres
Grand Canyon National Park	1,904	1,218,375
Grand Canyon–Parashant National Monument	1,638	1,048,316
Grand Canyon Game Preserve	997	638,080
Vermilion Cliffs National Monument	459	294,000
Total for Withdrawn Areas	**4,998**	**3,198,771**

2.4.2 Alternative A: No Action Alternative

Alternative A—Area Withdrawn

Under the No Action Alternative, the Secretary would not withdraw any of the lands identified in the Notice of Proposed Withdrawal from location and entry under the Mining Law. The proposed withdrawal area (see Figures 1.1-1 and 2.4-1) would remain open to location and entry under the Mining Law. New mining claims could be located. The BLM and Forest Service would continue to oversee locatable mineral exploration and development in accordance with their existing programs, policies, and regulations. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

Alternative A—Locatable Mineral Operating Requirements

Locatable mineral exploration and development on BLM land is subject to the surface management regulations at 43 CFR 3715 and 3809. Locatable mineral operations on National Forest land are regulated under 36 CFR 228A. The following is a brief description of the each agency's existing requirements.

On BLM land, locatable mineral operations beyond "casual use" require require compliance with 43 CFR subparts 3715 and 3809. Casual use is generally defined as "activities ordinarily resulting in no or negligible disturbance of the public lands or resources" [43 CFR 3809.5]. Exploration activities exceeding casual use can submit what is called a *notice* rather than a *plan of operations*, provided that the surface disturbance is less than 5 acres and does not occur in what are called special-category lands [43 CFR 3809.11(c)]. On special-category lands such as ACECs, Wild and Scenic Rivers, National Monuments, National Conservation Areas, designated wilderness areas, OHV closed areas, and threatened and endangered species critical habitat, even exploration on 5 acres or less must be authorized under a mining plan of operations. All other operations other than casual use and exploration activities that can be authorized under a notice must submit a detailed plan of operations to the BLM for review and approval. In addition, if the lands contained in the notice or plan of operations are withdrawn from the operation of the Mining Law, the BLM must verify that the underlying mining claims or sites are valid before approving new mining operations (43 CFR 3809.100). Areas disturbed must be reclaimed upon completion of operations. The operator is required to provide the BLM with an approved financial guarantee that is adequate to cover the estimated cost to complete the reclamation plan before beginning activities under either a notice or plan of operations. In addition, under the regulations at 3715, the BLM must make a formal decision of concurrence before a proposed occupancy of a mining claim or millsite can occur. This is usually done in conjunction with the review of a notice or approval of a plan of operations.

On National Forest System lands, for most locatable mineral operations, "a notice of intent to operate is required from any person proposing to conduct operations which might cause significant disturbance of surface resources" [36 CFR 228.4(a)]. The requirement is further defined and clarified in the regulations. If the operation is likely to cause significant disturbance of surface resources, a plan of operations must be submitted in lieu of the notice of intent. The determination of the significance of surface disturbance is made by the District Ranger, in accordance with Forest Service Manual 2810, Section 2817.11. In either case, "if the District Ranger determines that any operation is causing or will likely cause significant disturbance of surface resources, the District Ranger shall notify the operator that the operator must submit a proposed plan of operations for approval and that the operations cannot be conducted until a plan of operations is approved" [36 CFR 228.4(a)(4)].

The review and approval of a plan of operations by the BLM or Forest Service involve the following basic steps: 1) review of the proposed plan of operations to determine whether the operator has submitted complete operating, reclamation, monitoring, and interim management plans; 2) NEPA analysis, including the opportunity for public comment; 3) development of mitigating measures as conditions of approval required to meet the requirements of the regulations; 4) determination of the reclamation cost and financial guarantee amount; and 5) approval of the plan of operations and financial guarantee instrument. The approved plan of operations is subject to compliance monitoring by the BLM or Forest Service to ensure that the operator is following the approved plan.

Operations conducted under a *notice*, *notice of intent*, or an approved *plan of operations* must comply with all applicable state and federal laws and regulations related to environmental protection.

A more detailed description of the operating requirements of each agency is in Table 2.7-2 and in Appendix B.

Alternative A—Reasonably Foreseeable Future Activity

Uranium is the primary locatable mineral commodity of interest in the proposed withdrawal area. In this region uranium deposits of economic interest occur within geological structures termed breccia pipes. There are 45 confirmed breccia pipes within the proposed withdrawal area. Twenty-six of these confirmed breccia pipes are known to have some level of mineralization that may be economic to develop. Based on confirmed breccia pipe occurrence, as well as uranium resource estimates made by the USGS for the proposed withdrawal area, the RFD scenario estimates that 30 underground uranium mines could be developed within the proposed withdrawal area over the next 20 years (that is, 26 new mines in addition to the four already approved). An approved plan of operations would be required for each new mine and would include detailed project planning and NEPA review, as described above.

In the North Parcel, the BLM believes that 18 new mines can be reasonably foreseen to come into production over the next 20 years in addition to the three that existed prior to the Proposed Withdrawal—Pinenut, Arizona 1, and Kanab North. The Arizona 1 Mine is in active production, while the Pinenut and Kanab North Mines are operating under interim management as approved in their plans of operation. The total estimated surface disturbance is estimated to be 945 acres from exploration and development in the North Parcel over 20 years. It is estimated that 221,298 ore haul trips would be associated with this level of mining activity.

Each mine would likely require a deep production well for operational water during the average 5-year life span of the mine, with most water usage occurring during the anticipated 3-year ore production phase. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 221 million gallons (mgal) of water could be required for mine operations in the North Parcel over 20 years.

A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-2. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would be present at the same time.

Table 2.4-2. Reasonably Foreseeable Future Activity, Alternative A, North Parcel

Alternative A (No Action)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	504	25 projects/year
Acres disturbed for exploration (1.1 acres/project)	554	28 acres/year
Predicted mining projects (3 existing + 18 new)	21	1 mine/year
Acres new disturbance for mining (20 acres/mine)	360	18 acres/year
Number of ore haul trips (25 tons ore/trip)	221,298	11,065 trips/year
Miles of new power lines (parallel to access roads)	16.4	0.8 mile/year
Miles of new roads for new mine access	16.4	0.8 mile/year
Total acres disturbed for exploration and development	945	47 acres/year
Water usage (10.5 mgal/mine)	221	11 mgal/year

In the East Parcel, there are no existing mines, although two new mines are possible over the next 20 years, based on the RFD scenario. The total estimated surface disturbance is 107 acres from exploration and development in the East Parcel over 20 years. It is estimated that 22,240 ore haul trips would occur from mining in the East Parcel.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 21 mgal of water would be required for mine operations in the East Parcel over 20 years.

A breakdown by the type of activity that could occur in the East Parcel is shown below in Table 2.4-3. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

Table 2.4-3. Reasonably Foreseeable Future Activity, Alternative A, East Parcel

Alternative A (No Action)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	56	3 projects/year
Acres disturbed for exploration (1.1 acres/project)	62	3 acres/year
Predicted mining projects (2 new)	2	–
Acres disturbed for new mining (20 acres/mine)	40	–
Number of ore haul trips required (25 tons ore/trip)	22,240	3,707 trips/year/mine
Miles of new power lines (parallel to access roads)	2.4	–
Miles of new roads for new mine access	2.4	–
Total acres disturbed for exploration and development	107	5 acres/year
Water usage (10.5 mgal/mine)	21	1 mgal/year

In the South Parcel, there is one existing uranium mine, the Canyon Mine, where the shaft has been partially developed, with an additional six new uranium mines likely to occur over the next 20 years, based on the RFD scenario. The total estimated surface disturbance is 312 acres in the South Parcel over 20 years from exploration and development. It is estimated that 73,967 ore haul trips could occur from mines in the South Parcel. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine, with most water being used during ore production. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 74 mgal of water could be required for mine operations in the South Parcel over 20 years.

A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-4. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3, at the end of this chapter, compares the amount of activity predicted by the RFD scenario for each alternative.

Table 2.4-4. Reasonably Foreseeable Future Activity, Alternative A, South Parcel

Alternative A (No Action)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	168	8 projects/year
Acres disturbed for exploration (1.1 acres/project)	185	9 acres/year
Predicted mining projects (1 existing + 6 new)	7	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	120	6 acres/year
Number of ore haul trips (25 tons ore/trip)	73,967	3,698 trips/year
Miles of new power lines (parallel to access roads)	3.6	–
Miles of new roads for new mine access	3.6	–
Total acres disturbed for exploration and development	312	16 acres/year
Water usage (10.5 mgal/mine)	74	4 mgal/year

2.4.3 Alternative B: Proposed Action (20-Year Withdrawal) and Preferred Alternative

Alternative B—Area Withdrawn

Alternative B is the Preferred Alternative. Alternative B is the proposed withdrawal from location and entry under the Mining Law of the federal locatable mineral estate underlying approximately 626,678 acres of BLM land, 355,874 acres of National Forest land, 4,204 acres of state lands, and 19,789 acres of private lands in the North, East, and South parcels, subject to valid existing rights. These lands are identified by legal description in the July 21, 2009, *Federal Register* Notice of Proposed Withdrawal and Opportunity for Public Meeting (see Appendix A) and shown in Figures 1.1-1 and 2.4-1. The private and state lands within the parcel boundaries with non-federal mineral estate would not be subject to the proposed withdrawal. However, if these lands were ever acquired by the federal government through means such as sale or exchange, they would be subject to the withdrawal and closed to locatable mineral exploration and development.

The proposed withdrawal would prohibit the location of new mining claims. Exploration or development operations on BLM and National Forest System lands on existing mining claims under notices or plans of operation submitted after the effective date of the withdrawal would not be able to proceed unless the subject mining claim were determined to be valid under the Mining Law as of the date of the segregation, July 21, 2009. The mitigation of potential effects from these exploration or development operations would continue under the applicable surface managing agency regulations.

Neither the proposed withdrawal nor any alternative withdrawal would have any effect on rights-of-way (ROWs) or access to non-federal lands within the areas proposed for withdrawal. The BLM and Forest Service would continue to process ROW applications in the same manner as prior to the July 21, 2009, segregation.

Alternative B—Locatable Mineral Operating Requirements

Locatable mineral operations would continue to be managed under the operating requirements described above for Alternative A. Locatable mineral operations on BLM land are subject to the surface management regulations at 43 CFR 3809. Locatable mineral operations on National Forest System land are regulated under 36 CFR 228A. A key difference under Alternative B is that the BLM and Forest Service would only process new notices and plans of operation on mining claims located prior to July 21, 2009, and where it was determined that the mining claim was valid as of the date of the segregation and remains valid.

On BLM land, existing mining claims in the withdrawn area would be subject to provisions of 43 CFR 3809.100(a), which states, “After the date on which the lands are withdrawn from appropriation under the mining laws, BLM will not approve a plan of operations or allow notice-level operations to proceed until BLM has prepared a mineral examination report to determine whether the mining claim was valid before the withdrawal, and whether it remains valid.” During the preparation of a mineral examination, activities would be limited to sampling and testing in order to verify the presence of a discovery or to perform required annual assessment work. The time frame listed in the regulations for responding to a notice or plan of operations would be suspended pending the results of the mineral examination.

If the mineral examination determines that the mining claims involved in the notice or plan of operations are valid, i.e., held by a discovery of a valuable mineral deposit under the Mining Law, then the notice or plan of operations would continue to be processed in accordance with the regulations at 43 CFR 3809. If the mineral examination determined that the mining claims were not valid, then the BLM would not approve the plan of operations or allow notice-level activities to proceed and may institute contest proceedings against the subject mining claims.

On National Forest System lands, the Forest Service would follow essentially the same procedure as explained above for BLM lands. Under established agency policy, the Forest Service would not accept a notice of intent nor approve a plan of operations unless and until the subject mining claims were examined and determined to be valid under the Mining Law as of July 21, 2009, and remain valid.

Alternative B—Reasonably Foreseeable Future Activity

Reasonably foreseeable locatable mineral exploration and development operations under Alternative B are expected to be considerably more limited than under Alternative A because the area would be closed to new mining claim location. The only activity, in addition to the current approved operations, would be on existing mining claims determined valid as of July 21, 2009. Based on the number of confirmed breccia pipes within the proposed withdrawal area, it is estimated that in addition to the four existing uranium mines, seven more uranium mines could be developed.

In the North Parcel, there are three mines under plans of operation approved before the Notice of Proposed Withdrawal segregated the area—Arizona 1, Kanab North, and Pinenut—and seven mineralized breccia pipes with estimated uranium resources that are currently held under mining claims and would be likely to be developed into production. Ten mines could therefore operate during the 20-year time frame.

The total estimated surface disturbance from these mines, 10 additional drilling projects (incidental to existing claims), 6.4 miles of new power lines, and 6.4 miles of new roads is 163 acres in the North Parcel over 20 years. It is estimated that 98,978 ore haul trips could occur as a result of mining in the North Parcel.

It is estimated that a total of 105 mgal of water could be required over 20 years to support mine operations. A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-5. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

In the East Parcel, there are no existing mines, and there is only one breccia pipe confirmed through drilling. No mineral exploration or development is anticipated in this parcel under Alternative B, as it is unlikely any of the approximately two dozen mining claims had identified a valuable mineral deposit prior to July 21, 2009.

In the South Parcel, there is one partially developed mine, the Canyon Mine, but there are no other breccia pipes with estimated uranium resources. Therefore, it is likely that only the Canyon Mine would operate over the next 20 years. Total estimated surface disturbance from this mine is the 20 acres of existing disturbance and 1 acre related to drilling. It is estimated that 7,247 ore haul trips from mining in the South Parcel could occur based on the resources assumed to be present at the Canyon Mine. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Table 2.4-5. Reasonably Foreseeable Future Activity, Alternative B, North Parcel

Alternative B (Proposed Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	10	<1 project/year
Acres disturbed for exploration (1.1 acres/project)	11	<1 acres/year
Predicted mining projects (3 existing + 7 new)	10	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	140	7 acres/year
Number of ore haul trips (25 tons ore/trip)	98,978	4,949 trips/year
Miles of new power lines (parallel to access roads)	6.4	0.3 mile/year
Miles of new roads for new mine access	6.4	0.3 mile/year
Total acres disturbed for exploration and development	163	8 acres/year
Water usage (10.5 mgal/mine)	105	5 mgal/year

It is estimated that a total of 11 mgal of water could be required to support the Canyon Mine operations. A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-6. Because of the low level of activity, essentially one mine, it is likely that the drilling or mine disturbance would occur within a 4- to 5-year time frame, rather than being spread out evenly over 20 years.

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3 at the end of this chapter compares the amount of activity predicted by the RFD scenario for each alternative.

Table 2.4-6. Reasonably Foreseeable Future Activity, Alternative B, South Parcel

Alternative B (Proposed Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	1	–
Acres disturbed for exploration (1.1 acres/project)	1	–
Predicted mining projects (1 existing)	1	–
Acres new disturbance for mining (20 acres/mine)	0	–
Number of ore haul trips (25 tons ore/trip)	7,247	362 trips/year/mine
Miles of new power lines (parallel to access roads)	0	0 new
Miles of new roads for new mine access	0	0 new
Total acres disturbed for exploration and development	1	–
Water usage (10.5 mgal/mine)	11	~2 mgal/year/mine

2.4.4 Alternative C: Partial Withdrawal

Alternative C—Area Withdrawn

Alternative C is the withdrawal from location and entry under the Mining Law of the federal locatable mineral estate underlying approximately 400,174 acres of BLM land, 233,469 acres of National Forest System land, 4,204 acres of state lands, and 10,958 acres of private lands in the North, East, and South parcels subject to valid existing rights. This is only a portion of the area proposed to be withdrawn under Alternative A, the Proposed Action. The private and state lands within the Alternative C withdrawal area with non-federal mineral estate would not be subject to the withdrawal. However, if these lands were ever acquired by the federal government through means such as sale or exchange, they would be subject to the withdrawal and closed to locatable mineral exploration and development.

The location of new mining claims would be prohibited within the Alternative C withdrawal area. Exploration or development operations on BLM and National Forest System land on existing mining claims under notices or plans of operation submitted after the effective date of the withdrawal would not be able to proceed unless the involved mining claim were determined to be valid under the Mining Law as of the date of the segregation, July 21, 2009.

Implementation of Alternative C would not have any effect on ROWs or access to non-federal lands within the areas proposed for withdrawal. The BLM and Forest Service would continue to process ROW applications in the same manner as prior to the July 21, 2009, segregation.

This alternative would withdraw those contiguous areas with a high concentration of natural resources. The remaining areas would stay open to locatable mineral exploration and development. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations. Under Alternative C, the withdrawal of 648,805 acres amounts to approximately 65% of the total area being proposed for withdrawal under Alternative B (64% of the North Parcel, 67% of the East Parcel, and 64% of the South Parcel).

In the North Parcel, the 351,967 acres that would be withdrawn under this alternative include all or part of three ACECs—Johnson Spring, Kanab Creek, and Moonshine Ridge—as well as other lands known to contain cultural, biological, recreational, visual, and hydrologic resources. The Alternative C withdrawal boundaries and the identified areas of resource occurrence within the North Parcel are shown in Figure 2.4-2.

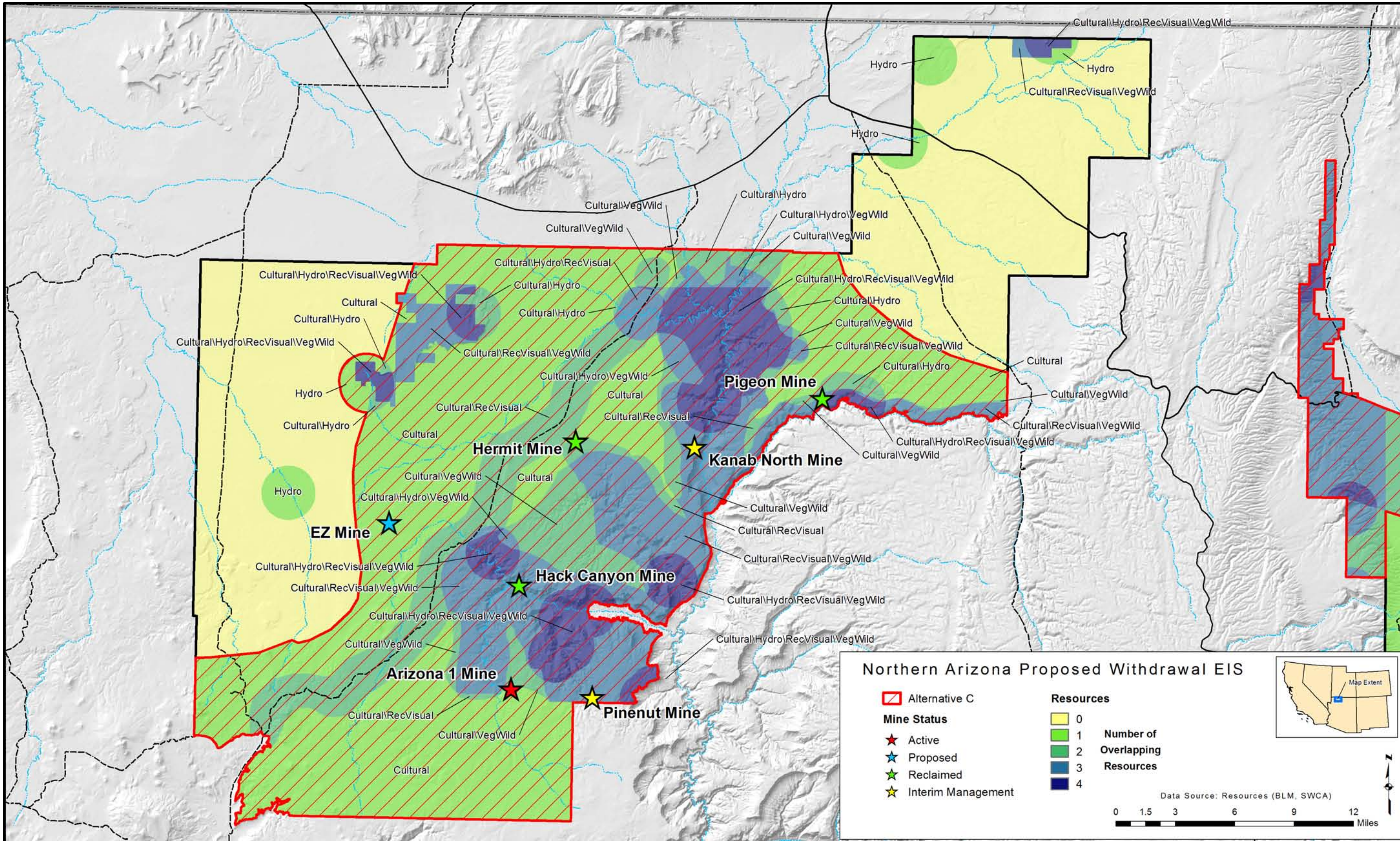


Figure 2.4-2. Alternative C partial withdrawal boundary: North Parcel.

In the East Parcel, the 90,234 acres that would be withdrawn under this alternative includes the contiguous area with a high concentration of cultural, biological, recreational, visual, and hydrologic resources. This includes the lands along the southern boundary of Vermilion Cliffs National Monument and land adjacent to Marble Canyon. The Alternative C withdrawal boundaries and the identified areas of resource occurrence within the East Parcel are shown in Figure 2.4-3.

In the South Parcel, the 206,603 acres that would be withdrawn under this alternative form a contiguous area with a high concentration of cultural, biological, recreational, visual, and hydrologic resources. The proposed withdrawal includes Red Butte, regarded by American Indian tribes as a sacred site, and the Coconino Rim area, which is also important to area tribes. The Alternative C withdrawal area includes the Grand Canyon Railroad route and the area east and west of State Route (SR) 64, the entrance corridor to Grand Canyon National Park. The Alternative C withdrawal boundaries and areas of resource occurrence within the South Parcel are shown in Figure 2.4-4.

Alternative C—Locatable Mineral Operating Requirements

Locatable mineral operations would continue to be managed under the operating requirements described above for Alternative A. A key difference under Alternative C is that within the Alternative C withdrawal area, the BLM and Forest Service would only process new notices and plans of operation on mining claims located prior to July 21, 2009, and where it was determined that the mining claim was valid as of the date of the segregation and remains valid.

On BLM land, existing mining claims in the withdrawn area would be subject to provisions of 43 CFR 3809.100(a), which states, “After the date on which the lands are withdrawn from appropriation under the mining laws, BLM will not approve a plan of operations or allow notice-level operations to proceed until BLM has prepared a mineral examination report to determine whether the mining claim was valid before the withdrawal, and whether it remains valid.” During the preparation of a mineral examination, activities would be limited to sampling and testing in order to verify the presence of a discovery or to perform required annual assessment work. The time frames in the regulations for responding to a notice or plan of operations would be suspended pending the results of the mineral examination.

If the mineral examination determines that the mining claims involved in the notice or plan of operations are valid, i.e., held by a discovery of a valuable mineral deposit under the Mining Law, then the notice or plan of operations would continue to be processed in accordance with the regulations at 43 CFR 3809. If the mineral examination determined that the mining claims were not valid, then the BLM would not approve the plan of operations or allow notice-level activities to proceed and would institute contest proceedings against the subject mining claims.

On National Forest System lands, the Forest Service would follow essentially the same procedure as explained above for BLM lands. Under established agency policy, the Forest Service would not accept a notice of intent nor approve a plan of operations unless and until the subject mining claims were examined and determined to be valid under the Mining Law as of July 21, 2009, and remain valid.

Alternative C—Reasonably Foreseeable Future Activity

Reasonably foreseeable mineral exploration and development operations under Alternative C are expected to be considerably more limited than under Alternative A since more than two-thirds of the area would be withdrawn. On lands included in the Alternative C withdrawal, the only development in addition to the currently approved operations within the withdrawn area would be on existing mining claims determined to be valid as of July 21, 2009. Outside the area that would be withdrawn in this alternative, new mining claims could be located and exploration and development could proceed the same as on any BLM or National Forest System land open to operation of the Mining Law.

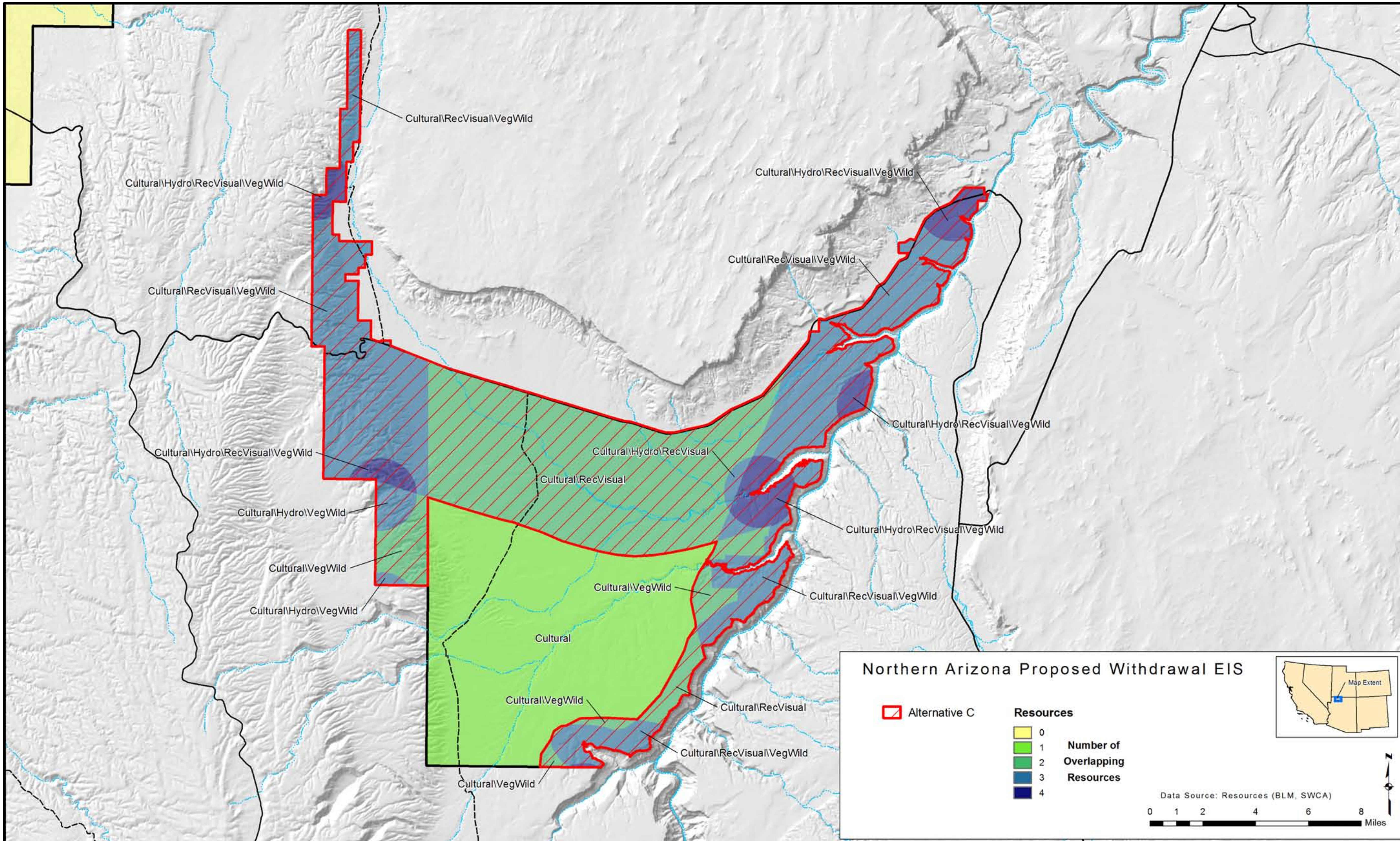


Figure 2.4-3. Alternative C partial withdrawal boundary: East Parcel.

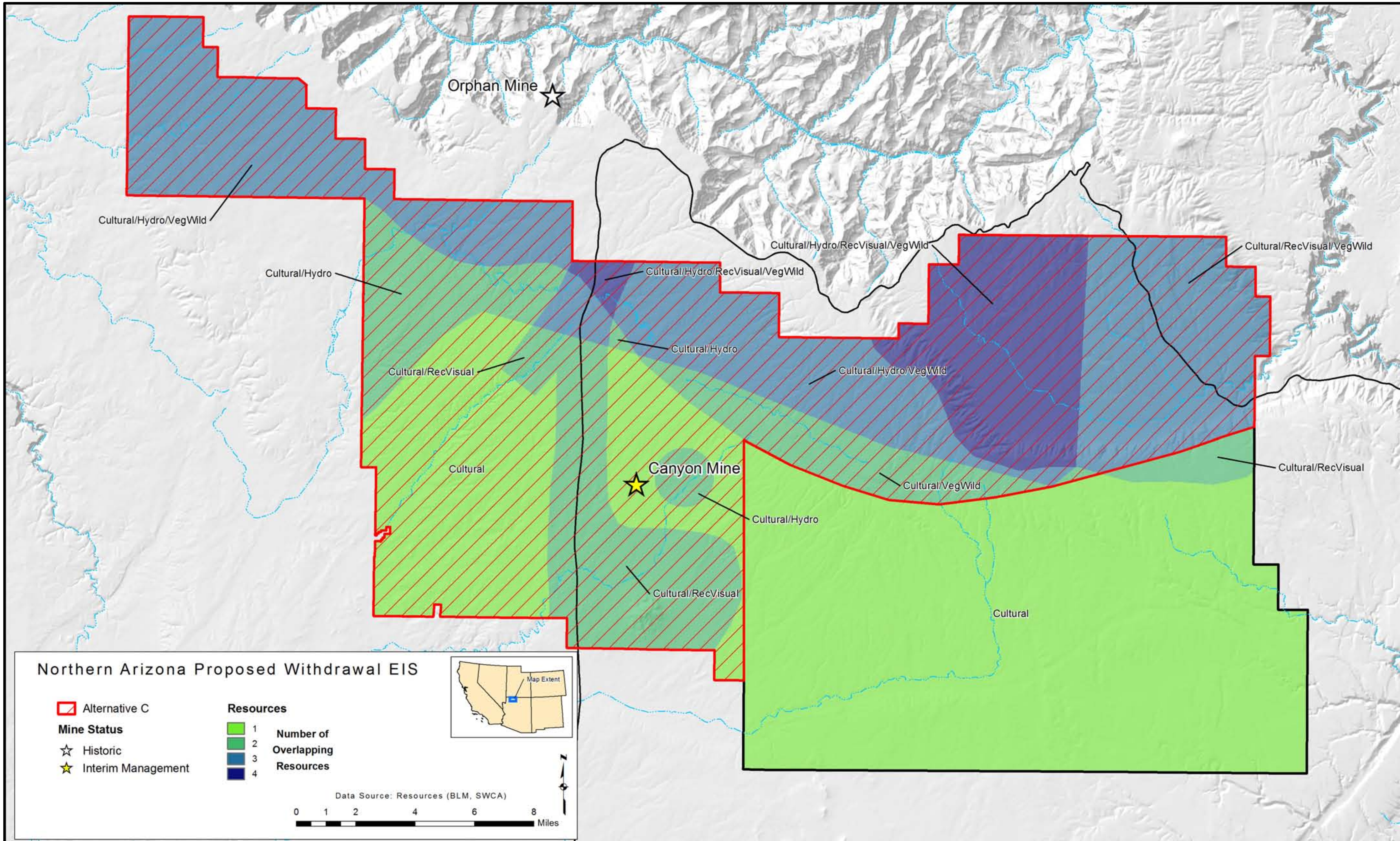


Figure 2.4-4. Alternative C partial withdrawal boundary: South Parcel.

Based on confirmed breccia pipe occurrence, as well as uranium resource estimates made by the USGS for the area, the RFD scenario estimates that 18 underground uranium mines could be developed within the area over the next 20 years. This includes both the area that would be withdrawn under this alternative and the portion of the area that would not be withdrawn under this alternative as shown in Figures 2.4-2 through 2.4-4. An approved plan of operations would be required for each new mine that would include detailed project planning and NEPA review, as described above.

In the North Parcel, there are three existing uranium mines—Pinenut, Arizona 1, and Kanab North—with an additional 10 new uranium mines that could be developed over the next 20 years. The total estimated surface disturbance as a result of exploration and development is 320 acres in the North Parcel over 20 years. It is estimated that 132,338 ore haul trips could occur as a result of mining in the North Parcel.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 137 mgal of water could be required for all the mine operations in the North Parcel over 20 years.

A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-7. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

In the East Parcel, there are no existing mines, although one new mine is predicted over the next 20 years, based on the RFD scenario. The total estimated surface disturbance is 54 acres from exploration and development over 20 years. It is estimated that 11,120 ore haul trips could occur as a result of mining in the East Parcel.

The new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 11 mgal of water would be required for mine operations in the East Parcel.

Table 2.4-7. Reasonably Foreseeable Future Activity, Alternative C, North Parcel

Alternative C (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	94	5 projects/year
Acres disturbed for exploration (1.1 acres/project)	103	5 acres/year
Predicted mining projects (3 existing + 10 new)	13	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	200	10 acres/year
Number of ore haul trips (25 tons ore/trip)	132,338	6,617 trips/year
Miles of new power lines (parallel to access roads)	9.1	0.5 mile/year
Miles of new roads for new mine access	9.1	0.5 mile/year
Total acres disturbed for exploration and development	320	16 acres/year
Water usage (10.5 mgal/mine)	137	7 mgal/year

A breakdown by the type of activity that could occur in the East Parcel is shown below in Table 2.4-8. Because of the low level of activity (essentially one mine), it is likely that the mining disturbance would occur within a 4- to 5-year time frame, rather than being spread out over 20 years.

Table 2.4-8. Reasonably Foreseeable Future Activity, Alternative C, East Parcel

Alternative C (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	28	1 project/year
Acres disturbed for exploration (1.1 acres/project)	31	2 acres/year
Predicted mining projects (1 new)	1	–
Acres new disturbance for mining (20 acres/mine)	20	–
Number of ore haul trips (25 tons ore/trip)	11,120	2,240 trips/year/mine
Miles of new power lines (parallel to access roads)	1.2	–
Miles of new roads for new mine access	1.2	–
Total acres disturbed for exploration and development	54	–
Water usage (10.5 mgal/mine)	11	~2 mgal/year/mine

In the South Parcel, there is one existing mine, the Canyon Mine, which is operating under interim management approved as a part of their plan of operation. An additional three new mines are likely to occur somewhere in that portion of the parcel that would not be withdrawn under this alternative over the next 20 years, based on the RFD scenario. The total estimated surface disturbance from exploration and development is 158 acres in the South Parcel over 20 years. It is estimated that 40,607 ore haul trips could occur as a result of mining in the South Parcel. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 42 mgal of water could be required for mine operations in the South Parcel over 20 years.

A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-9. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

Table 2.4-9. Reasonably Foreseeable Future Activity, Alternative C, South Parcel

Alternative C (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	85	4 projects/year
Acres disturbed for exploration (1.1 acres/project)	94	5 acres/year
Predicted mining projects (1 existing + 3 new)	4	–
Acres new disturbance for mining (20 acres/mine)	60	3 acres/year
Number of ore haul trips (25 tons ore/trip)	40,607	2,030 trips/year
Miles of new power lines (parallel to access roads)	1.8	–
Miles of new roads for new mine access	1.8	–
Total acres disturbed for exploration and development	158	8 acres/year
Water usage (10.5 mgal/mine)	42	2 mgal/year

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3 at the end of this chapter compares the amount of activity predicted by the RFD scenario for each alternative.

2.4.5 Alternative D: Partial Withdrawal

Alternative D—Area Withdrawn

Alternative D is the withdrawal from location and entry under the Mining Law of the federal locatable mineral estate underlying approximately 129,078 acres of BLM land, 160,693 acres of National Forest land, 801 acres of state lands, and 1,516 acres of private lands in the North, East, and South parcels, subject to valid existing rights. This is only a portion of the area proposed to be withdrawn under Alternative A, the Proposed Action, and a smaller area than what would be withdrawn under Alternative C, another partial withdrawal alternative. The private and state lands within the Alternative D withdrawal area with non-federal mineral estate would not be subject to the proposed withdrawal. However, if these lands were ever acquired by the federal government through means such as sale or exchange, they would be subject to the withdrawal and closed to locatable mineral exploration and development.

The location of new mining claims would be prohibited within the Alternative D withdrawal area. Exploration or development operations on BLM and National Forest System land on existing mining claims under notices or plans of operation submitted after the effective date of the withdrawal would not be able to proceed unless the involved mining claim were determined to be valid under the Mining Law as of the date of the segregation, July 21, 2009.

Implementation of Alternative D would not have any effect on ROWs or access to non-federal lands within the areas proposed for withdrawal. The BLM and Forest Service would continue to process ROW applications in the same manner as prior to the July 21, 2009, segregation.

This alternative would withdraw only those contiguous areas with the highest concentration of natural resources. The remaining areas would stay open to locatable mineral exploration and development. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations. Under Alternative D, the withdrawal of 292,088 acres amounts to approximately 29% of the total area being proposed for withdrawal under Alternative B (19% of the North Parcel, 42% of the East Parcel, and 41% of the South Parcel).

In the North Parcel, a total of 102,581 acres would be withdrawn under this alternative, including the Kanab Creek ACEC. The areas with the concentrations of cultural, biological, recreational, visual, and hydrologic resources to be withdrawn would include the area immediately adjacent to Kanab Creek, Grama Canyon, Hack Canyon, and Snake Gulch. The Alternative D withdrawal boundaries and identified areas of resource occurrence within the North Parcel are shown in Figure 2.4-5.

In the East Parcel, the 56,233 acres that would be withdrawn under this alternative include the areas with concentrations of cultural, biological, recreational, visual, and hydrologic resources. The area that would be withdrawn under this alternative is adjacent to Marble Canyon and the interface area between the Kaibab National Forest and Vermilion Cliffs National Monument. The Alternative D withdrawal boundaries and the identified areas of resource occurrence within the East Parcel are shown in Figure 2.4-6.

In the South Parcel, the 133,274 acres that would be withdrawn under this alternative include the contiguous area with the highest concentrations of cultural, biological, recreational, visual, and hydrologic resources. The area that would be withdrawn encompasses the northern portion of the Tusayan Ranger District north of the groundwater divide, including the Coconino Rim. The Alternative D withdrawal boundaries and areas of resource occurrence within the South Parcel are shown in Figure 2.4-7.

Alternative D—Locatable Mineral Operating Requirements

Locatable mineral operations would continue to be managed under the operating requirements described above for Alternative A. A key difference under Alternative D is that, within the Alternative D withdrawal area, the BLM and Forest Service would only process new notices and plans of operation on mining claims located prior to July 21, 2009, and where it was determined that the mining claim was valid as of the date of the segregation and remains valid.

On BLM land, existing mining claims in the withdrawn area would be subject to provisions of 43 CFR 3809.100(a), which states, “After the date on which the lands are withdrawn from appropriation under the mining laws, BLM will not approve a plan of operations or allow notice-level operations to proceed until BLM has prepared a mineral examination report to determine whether the mining claim was valid before the withdrawal, and whether it remains valid.” During the preparation of a mineral examination, activities would be limited to sampling and testing in order to verify the presence of a discovery or to perform required annual assessment work. The time frame listed in the regulations for responding to a notice or plan of operations would be suspended pending the results of the mineral examination.

If the mineral examination determines that the mining claims involved in the notice or plan of operations are valid, i.e., held by a discovery of a valuable mineral deposit under the Mining Law, then the notice or plan of operations would continue to be processed in accordance with the regulations at 43 CFR 3809. If the mineral examination determined that the mining claims were not valid, then the BLM would not approve the plan of operations or allow notice-level activities to proceed and would institute contest proceedings against the subject mining claims.

On National Forest System lands, the Forest Service would follow essentially the same procedure as explained above for BLM lands. Under established agency policy, the Forest Service would not accept a notice of intent nor approve a plan of operations unless and until the subject mining claims were examined and determined to be valid under the Mining Law as of July 21, 2009.

Alternative D—Reasonably Foreseeable Future Activity

Reasonably foreseeable mineral exploration and development operations under Alternative D are limited, compared with those described under Alternative A, since about one-third of the area would be withdrawn. On lands included in the Alternative D withdrawal, the only development in addition to the currently approved operations within the withdrawn area would be on existing mining claims determined valid as of July 21, 2009. Outside the area that would be withdrawn in this alternative, new mining claims could be located and exploration and development could proceed the same as on any BLM or National Forest System land open to operation of the Mining Law.

Based on confirmed breccia pipe occurrence, as well as uranium resource estimates made by the USGS for the area, the RFD scenario estimates that 26 underground uranium mines could be developed within the area over the next 20 years. This includes both the area that would be withdrawn under this alternative and the portion of the withdrawal area in the Proposed Action that would not be withdrawn under this alternative, as shown in Figures 2.4-5 through 2.4-7. An approved plan of operations would be required for each new mine and would include detailed project planning and NEPA review, as described above.

In the North Parcel, there are three existing uranium mines—Pinenut, Arizona 1, and Kanab North—with an additional 17 new uranium mines that could be developed over the next 20 years. The total estimated surface disturbance from exploration and development is 688 acres in the North Parcel over 20 years. It is estimated that 210,178 ore haul trips could occur as a result of mining in the North Parcel.

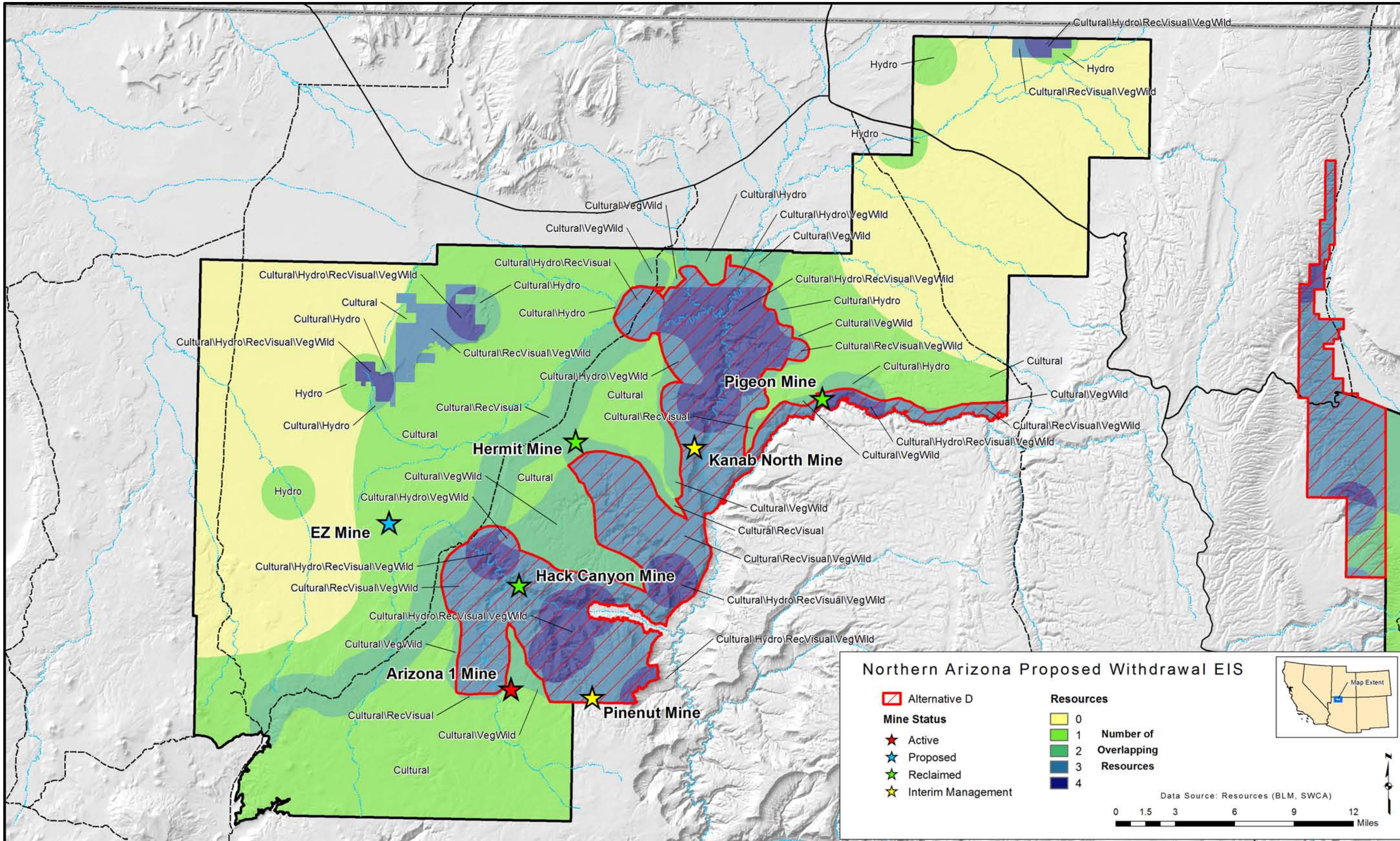


Figure 2.4-5. Alternative D partial withdrawal boundary: North Parcel.

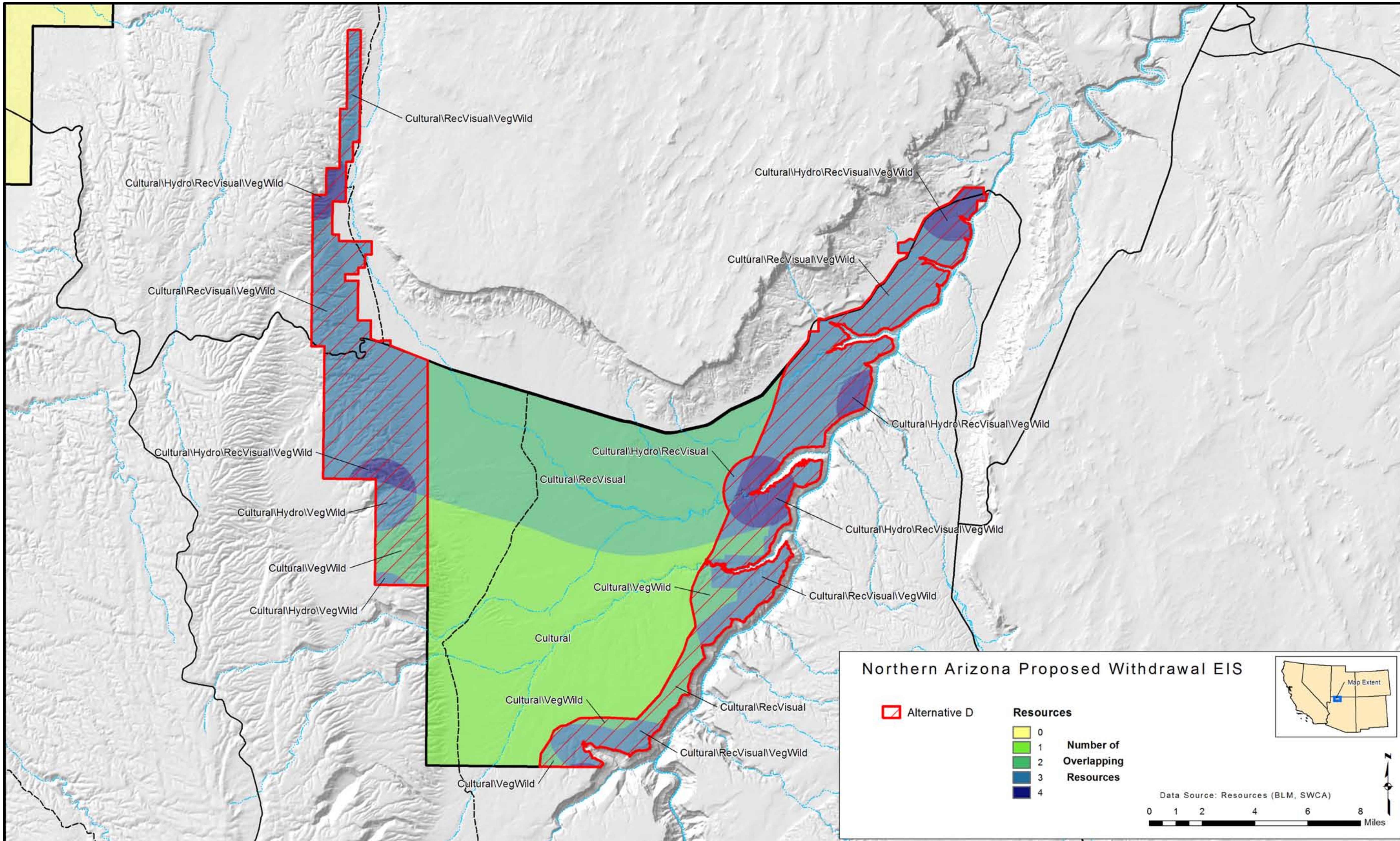


Figure 2.4-6. Alternative D partial withdrawal boundary: East Parcel.

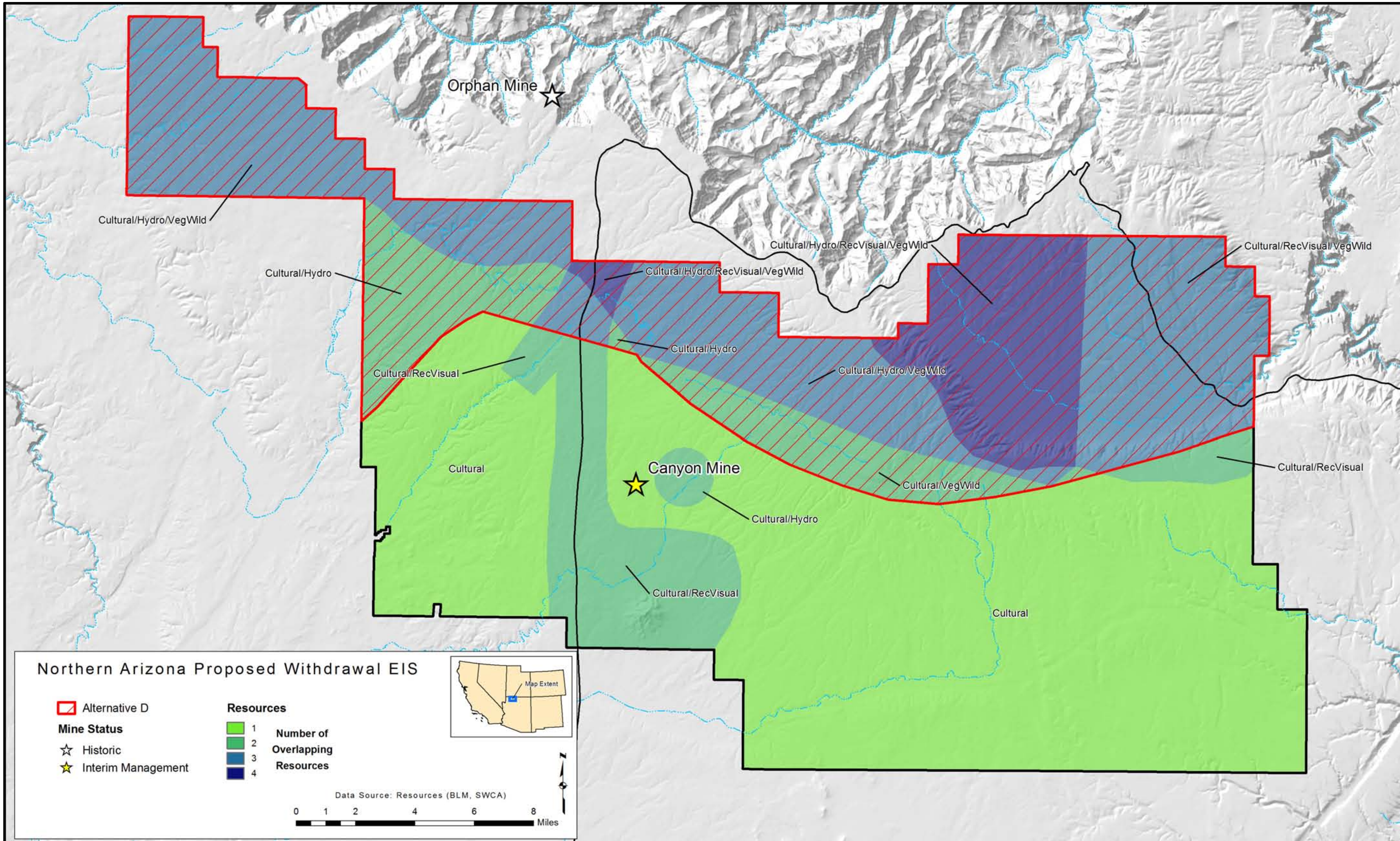


Figure 2.4-7. Alternative D partial withdrawal boundary: South Parcel.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 210 mgal of water could be required for mine operations in the North Parcel over 20 years.

A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-10. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

In the East Parcel, there are no existing mines, although one new mine is possible over the next 20 years, based on the RFD scenario. The total estimated surface disturbance from exploration and development is 54 acres in the East Parcel over 20 years. It is estimated that 11,120 ore haul trips could occur as a result of mining in the East Parcel.

The new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 11 mgal of water would be required for mine operations in the East Parcel.

A breakdown by the type of activity that could occur in the East Parcel is shown below in Table 2.4-11. Because of the low level of activity, essentially one mine, it is likely the mining disturbance would occur within a 4- to 5-year time frame, rather than being spread out over 20 years.

Table 2.4-10. Reasonably Foreseeable Future Activity, Alternative D, North Parcel

Alternative D (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	290	15 projects/year
Acres disturbed for exploration (1.1 acres/project)	319	16 acres/year
Predicted mining projects (3 existing + 17 new)	20	1 mine/year
Acres new disturbance for mining (20 acres/mine)	340	17 acres/year
Number of ore haul trips (25 tons ore/trip)	210,178	10,509 trips/year
Miles of new power lines (parallel to access roads)	15.5	0.8 mile/year
Miles of new roads for new mine access	15.5	0.8 mile/year
Total acres disturbed for exploration and development	688	34 acres/year
Water usage (10.5 mgal/mine)	210	11 mgal/year

Table 2.4-11. Reasonably Foreseeable Future Activity, Alternative D, East Parcel

Alternative D (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	28	1 project/year
Acres disturbed for exploration (1.1 acres/project)	31	2 acres/year
Predicted mining projects (1 new)	1	–
Acres new disturbance for mining (20 acres/mine)	20	–
Number of ore haul trips (25 tons ore/trip)	11,120	2,240 trips/year/mine
Miles of new power lines (parallel to access roads)	1.2	–
Miles of new roads for new mine access	1.2	–
Total acres disturbed for exploration and development	54	–
Water usage (10.5 mgal/mine)	11	~2 mgal/year/mine

In the South Parcel, there is one existing mine, the Canyon Mine, which has been partially developed and is operating under interim management approved as a part of their plan of operation, with an additional four new uranium mines likely to occur somewhere in the portion of the parcel that would not be withdrawn under this alternative over the next 20 years, based on the RFD scenario. The total estimated surface disturbance from exploration and development is 209 acres in the South Parcel over 20 years. It is estimated that 51,727 ore haul trips could occur as a result of mining in the South Parcel. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 53 mgal of water could be required for mine operations in the South Parcel over 20 years.

A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-12. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3 at the end of this chapter compares the amount of activity predicted by the RFD scenario for each alternative.

Table 2.4-12. Reasonably Foreseeable Future Activity, Alternative D, South Parcel

Alternative D (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	113	6 projects/year
Acres disturbed for exploration (1.1 acres/project)	124	6 acres/year
Predicted mining projects (1 existing + 4 new)	5	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	80	4 acres/year
Number of ore haul trips (25 tons ore/trip)	51,727	2,586 trips/year
Miles of new power lines (parallel to access roads)	2.4	–
Miles of new roads for new mine access	2.4	–
Total acres disturbed for exploration and development	209	10 acres/year
Water usage (10.5 mgal/mine)	53	3 mgal/year

2.5 CUMULATIVE ACTIONS

All existing and anticipated exploration and development operations are included as part of the RFD scenarios used to predict reasonably foreseeable future actions and activities. The three mines within the area proposed for withdrawal (Canyon, Pinenut, and Kanab North) are under interim management, consistent with their approved plans of operation. Arizona 1 is the only uranium mining operation currently in production within the area proposed for withdrawal. All four of these mines are included in the RFD analysis (see Appendix B).

The BLM is currently reviewing a plan of operations for mining of the EZ-1, EZ-2, and What deposits in the North Parcel (see Figure 2.4-5, labeled EZ MINE). These deposits are proximally located and are planned to be mined from a single mine location. Potential development of these deposits is included as part of the RFD scenarios (see Appendix B). Site-specific analysis, findings, and decisions regarding the EZ-1, EZ-2, and What plan of operations will be made by BLM after preparation of a separate, project-specific environmental analysis is completed. A site-specific analysis of that plan of operations is not within the scope of the current EIS.

On October 10, 2008, the Kaibab National Forest published a *Federal Register* NOI to prepare an EIS on the proposed exploration of 24 mining claims in the South Parcel held by VANE Minerals, Inc. (VANE). VANE must prove valid existing rights prior to the July 21, 2009, segregation in order to conduct exploration. However, VANE subsequently withdrew the plan of operations. The Forest Service is not currently reviewing any plans of operation within the area proposed for withdrawal. Potential exploration and possible mine development of these claims is included as part of the RFD scenarios (see Appendix B). A site-specific analysis of the VANE exploration plan of operations is not within the scope of the current EIS.

Other reasonably foreseeable, non-mineral-related actions that could contribute to cumulative impacts, such as recreational use, OHV use, and road construction, are presented and analyzed in the individual resource sections in Chapter 4, where the potential for a specific cumulative impact is identified.

2.6 PREFERRED ALTERNATIVE IDENTIFICATION

The CEQ regulations at 40 CFR 1502.14(e) and Department of Interior regulations at 43 CFR 46.425 direct that an EIS “identify the agency’s preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference.” According to CEQ, the agency’s preferred alternative “is the alternative that the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors” (CEQ 1981:Question 4). The BLM did not identify a preferred alternative in the DEIS and actively solicited public comments and input with respect to the identification of a preferred alternative. Based on a review of public comments and following extensive inter-agency consultation, and as directed by the Secretary of the Interior, the BLM is identifying Alternative B, the Proposed Action, as the Preferred Alternative in this FEIS.

For actions presented in this EIS, the decision-maker is the Secretary of the Interior. The EIS is being prepared to objectively provide the decision-maker with a range of reasonable alternatives, each analyzed to a comparable level of detail. As stated in the Draft EIS, the preferred alternative could have been any one of the alternatives presented in the Draft EIS, or some combination or minor variation of the alternatives presented. In accordance with NEPA [40 CFR 1502.9(1)], a preferred alternative within the spectrum of alternatives analyzed in the Draft EIS will not require supplementation (CEQ 1981:Question 29b). As noted above, BLM has identified Alternative B, the Proposed Action, as the Preferred Alternative in this FEIS.

2.7 COMPARISON OF ALTERNATIVES

Table 2.7-1 identifies the approximate number of acres of federal locatable mineral estate, by alternative and by proposed withdrawal parcel, that could be withdrawn for a period of 20 years from the location of new mining claims under the Mining Law. Table 2.7-2 identifies the locatable mineral exploration and development operating requirements by agency (i.e., BLM or Forest Service). Table 2.7-3 identifies the RFD-related activities that are anticipated under each alternative over 20 years.

Table 2.7-1. Federal Locatable Mineral Estate (Acres) Subject to Withdrawal by Alternative and by Parcel

Proposed Withdrawal Parcel	Alternative A No Action Area Open under the Mining Law	Alternative B Proposed Action 20 Years (~1 Million Acres Withdrawn)		Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)		Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)	
North	None	<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>	
		BLM	524,246	BLM	335,048	BLM	97,634
		FS*	3,466	FS	3,466	FS	3,466
		State	4,204	State	4,204	State	801
		Private	18,079	Private	9,248	Private	681
		Total	*549,995*	*Total*	*351,967*	*Total*	*102,581*
East	None	<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>	
		BLM	102,432	BLM	65,126	BLM	31,444
		FS	31,273	FS	24,360	FS	24,360
		State	0	State	0	State	0
		Private	749	Private	749	Private	429
		Total	*134,454*	*Total*	*90,234*	*Total*	*56,233*
South	None	<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>	
		BLM	0	BLM	0	BLM	0
		FS	321,135	FS	205,643	FS	132,867
		State	0	State	0	State	0
		Private	961	Private	961	Private	407
		Total	*322,096*	*Total*	*206,603*	*Total*	*133,274*
Total Acres of Federal Locatable Mineral Estate to Be Withdrawn:	None	<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>		<u>*Surface Ownership*</u>	
		BLM	626,678	BLM	400,174	BLM	129,078
		FS	355,874	FS	233,469	FS	160,693
		State	4,204	State	4,204	State	801
		Private	19,789	Private	10,958	Private	1,516
		Total:	**1,006,545**	**Total:**	**648,805**	**Total:**	**292,088**

Note: FS = Forest Service.

Table 2.7-2. Locatable Mineral Exploration and Mine Operating Requirements

Agency	Alternatives A through D
BLM	Use and occupancy regulations at 43 CFR 3715; and surface management regulations at 43 CFR 3809. Major provisions include the following: • Surface use must be reasonably incident to mining, prospecting, and milling operations. • If the area is withdrawn, the mining claims involved must have valid existing rights. • Exploration disturbing less than 5 acres can usually be conducted under a notice. • All mining requires an approved plan of operations involving NEPA analysis and public comment. • All activity must prevent unnecessary or undue degradation, which requires complying with applicable state and federal environmental protection laws; meeting the performance standards in the BLM regulations for the protection or air, cultural, water, and wildlife resources; and isolating and controlling toxic or deleterious materials. • Exploration- and development-related disturbance must be reclaimed in accordance with the reclamation plan. • All operators must provide the BLM with a financial guarantee covering the full cost of reclaiming the operation in accordance with the reclamation plan. • The BLM can inspect operations for compliance with the regulations and issue administrative enforcement orders in cases of noncompliance. If a plan of operations meets the above requirements, it would be approved.

Table 2.7-2. Locatable Mineral Exploration and Mine Operating Requirements (Continued)

Agency	Alternatives A through D
Forest Service	Surface management regulations at 36 CFR 228A. Major provisions include the following: • Surface use must be reasonably incident to mining, prospecting, and milling operations. • If the area is withdrawn, the mining claims involved must have valid existing rights. • Operators proposing exploration or small-scale mining submit an NOI and may be allowed to conduct operations without a plan of operations if the proposed disturbance is not considered significant. • Mining operations entailing significant disturbance require an approved plan of operations involving NEPA analysis and public comment. • All activity must comply with applicable state and federal environmental protection laws; meeting the performance standards in the Forest Service regulations for the protection of air, cultural, water, and wildlife resources; and isolating and controlling toxic or deleterious materials. • Exploration- and development-related disturbance must be reclaimed in accordance with the reclamation plan. • All operators must provide the Forest Service with a reclamation bond covering the full cost of reclaiming the operation in accordance with the approved reclamation plan. • The Forest Service can inspect operations for compliance with the regulations and issue administrative enforcement orders in cases of noncompliance. If a plan of operations meets the above requirements, it would be approved.

Table 2.7-3. Reasonably Foreseeable Future Locatable Mineral Operations by Alternative (anticipated over 20 years)

Activity	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Predicted exploration projects				
North Parcel	504	10	94	290
East Parcel	56	0	28	28
South Parcel	168	1	85	113
Subtotal	*728*	*11*	*207*	*431*
Acres disturbed for exploration				
North Parcel	554	11	103	319
East Parcel	62	0	31	31
South Parcel	185	1	94	124
Subtotal	*801*	*12*	*228*	*474*
Predicted mining projects				
North Parcel	21	10	13	20
East Parcel	2	0	1	1
South Parcel	7	1	4	5
Subtotal	*30*	*11*	*18*	*26*
Acres disturbed for mining				
North Parcel	360	140	200	340
East Parcel	40	0	20	20
South Parcel	120	0	60	80
Subtotal	*520*	*140*	*280*	*440*

Table 2.7-3. Reasonably Foreseeable Future Locatable Mineral Operations by Alternative (anticipated over 20 years), Continued

Activity	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Number of ore haul trips required				
North Parcel	221,298	98,978	132,338	210,178
East Parcel	22,240	0	11,120	11,120
South Parcel	73,967	7,247	40,607	51,727
Subtotal	*317,505*	*106,225*	*184,065*	*273,025*
Miles of new power lines				
North Parcel	16.4	6.4	9.1	15.5
East Parcel	2.4	0	1.2	1.2
South Parcel	3.6	0	1.8	2.4
Subtotal	*22.4*	*6.4*	*12.1*	*19.1*
Miles of new roads for mine access				
North Parcel	16.4	6.4	9.1	15.5
East Parcel	2.4	0	1.2	1.2
South Parcel	3.6	0	1.8	2.4
Subtotal	*22.4*	*6.4*	*12.1*	*19.1*
Total acres disturbed for exploration and development over 20 years				
North Parcel	945	163	320	688
East Parcel	107	0	54	54
South Parcel	312	1	158	209
Subtotal	*1,364*	*164*	*532*	*951*
Water usage (mgal) over 20 years				
North Parcel	221	105	137	210
East Parcel	21	0	11	11
South Parcel	74	11	42	53
Subtotal	*316*	*116*	*190*	*274*

2.8 IMPACT SUMMARY COMPARISON

Table 2.8-1 provides a comparison of the potential environmental effects of Alternatives A through D. A detailed description of the environmental effects is provided in Chapter 4.

For the reasons discussed in the RFD (Appendix B) under Alternative B (full withdrawal), mining is projected to increase from current levels and is projected to increase significantly under Alternative A (No Action), with Alternatives C and D falling in between. For ease of reading, the impacts of mineral exploration and development activities on a specific resource under a particular alternative are generally characterized as no impact, minor, moderate, or major. This represents comparison to the status quo or baseline for that resource. However, in order to properly and meaningfully evaluate the impacts of mining under each alternative, the impacts expected from mining under that alternative should be measured against the impacts projected to occur under Alternative A, which is the baseline for purposes of comparison of the alternatives to one another, as it represents the amount of reasonably foreseeable mineral development should no withdrawal take place. That is, the true impact of a particular action alternative is the difference between the impacts under Alternative A and that particular alternative.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative

Resource Category/ Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Air Quality and Climate (4.2)				
Release of particulates	Over a 20-year period approximately 18,521tons of PM_{10} and 2,673 tons of $PM_{2.5}$ would be emitted to the atmosphere. On a per mine, per year basis the average emissions would be NO_X = 233, SO_2 = 0.53, CO = 157, PM_{10} = 926, $PM_{2.5}$ = 134, VOC = 23, and CO_2 = 22,580. Radon emissions would be $\leq$ 10 mrem/yr/mine. Emissions would be the greatest under this alternative.	Over a 20-year period approximately 7,105 tons of PM_{10} and 1,008 tons of $PM_{2.5}$ would be emitted to the atmosphere. On a per mine, per year basis the average emissions would be NO_X = 77, SO_2 = 0.18, CO = 50, PM_{10} = 355, $PM_{2.5}$ = 50, VOC = 8, and CO_2 = 7,589. Radon emissions would be $\leq$ 10 mrem/yr/mine. Emissions would be the least under this alternative. This represents an approximately 60% decrease in air pollutant emissions when compared to that of the No Action Alternative (No Withdrawal).	Over a 20-year period approximately 10,685 tons of PM_{10} and 1,557 tons of $PM_{2.5}$ would be emitted to the atmosphere. On a per mine, per year basis the average emissions would be NO_X = 132, SO_2 = 0.31, CO = 88, PM_{10} = 534, $PM_{2.5}$ = 78, VOC = 13, and CO_2 = 12,855. Radon emissions would be $\leq$ 10 mrem/yr/mine. This represents an approximately 40% decrease in air pollutant emissions when compared to that of the No Action Alternative (No Withdrawal).	Under Alternative D, over a 20-year period, approximately 16,270 tons of PM_{10} and 2,336 tons of $PM_{2.5}$ would be emitted to the atmosphere. On a per mine, per year basis the average emissions would be NO_X = 196, SO_2 = 0.45, CO = 130, PM_{10} = 813, $PM_{2.5}$ = 117, VOC = 19, and CO_2 = 19,037. Radon emissions would be $\leq$ 10 mrem/yr/mine. This represents an approximately 10% decrease in air pollutant emissions when compared to that of the No Action Alternative (No Withdrawal).
Increase in regional haze	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park.	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park. Inconclusive	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park.	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park.
Geology and Mineral Resources (4.3)				
Change in underground geological conditions	Number of ore deposits mined: *30. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change.*	Number of ore deposits mined: *11. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change.*	Number of ore deposits mined: *18. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change.*	Number of ore deposits mined: *26. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change*
Availability of mineral resources	Approximately 39,666 tons U_3O_8 mined over a 20-year time frame.	Approximately 10,658 tons U_3O_8 mined over a 20-year time frame.	Approximately 21,158 tons U_3O_8 mined over a 20-year time frame.	Approximately 33,158 tons U_3O_8 mined over a 20-year time frame.
Water Resources (4.4)				
Perched aquifer springs quantity and quality of water	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 13.3%.* *Potential impact:* 5% to 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates more than an 80% probability that any spring would not be impacted. East Parcel: *Probability of impact: 1.3%.* *Potential impact:* Between 0% and 5% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values indicates more than a 95% probability that any spring would not be impacted South Parcel: *Probability of impact: 0.2 %.* *Potential impact:* Between 0% and 5% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values indicates more than a 95% probability that any spring would not be impacted	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 5.4%.* *Potential impact:* 5% to 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates more than an 80% probability that any spring would not be impacted. East Parcel: *Probability of impact: 0%.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells. South Parcel: *Probability of impact: 0 %.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells.	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 6.7%.* *Potential impact:* 5% to 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates more than an 80% probability that any spring would not be impacted. East Parcel: *Probability of impact: 0%.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells. South Parcel: *Probability of impact: 0 %.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells.	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 10.8%.* *Potential impact:* 5% to 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates more than an 80% probability that any spring would not be impacted. East Parcel: *Probability of impact: 0%.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells. South Parcel: *Probability of impact: 0.3 %.* *Potential impact:* Between 0% and 5% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values indicates more than a 95% probability that any spring would not be impacted
Perched aquifer wells quantity and quality of water	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 11. East Parcel: Impacts could vary from no mines located where they may affect wells, to 1. South Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 4.	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 5. East Parcel: No mines located where they may affect wells. South Parcel: Impacts could vary from no mines located where they may affect wells, to 1.	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 7. East Parcel: Impacts could vary from no mines located where they may affect wells, to 1. South Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 2.	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 10. East Parcel: Impacts could vary from no mines located where they may affect wells, to 1. South Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 3.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Water Resources, continued				
Deep aquifer springs quantity of flow (R-aquifer)	Impact duration: *More than 5 years.* North Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 4.5% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). East Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 0.1% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). South Parcel: *For Havasu and Blue Springs,* the total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 0.1% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). *For South Rim springs,* the total anticipated volume of water withdrawn from mine-related R-aquifer wells would be from 0% to less than 2% for Hermit and Garden springs and from 0% to 100% for small springs of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (0% to more than 10%).	Impact duration: *More than 5 years.* North Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 2.1% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). East Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be 0% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells. (0%). South Parcel: *For Havasu Springs only:* The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 0.01% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). *For all other springs:* The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be 0% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (0%).	Impact duration: *More than 5 years.* North Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 2.8% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). East Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 0.05% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). South Parcel: *For Havasu Springs only:* The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 0.05% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). *For all other springs:* The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be 0% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (0%).	Impact duration: *More than 5 years.* North Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 4.3% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). East Parcel: The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 0.05% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). South Parcel: *For Havasu Springs only:* The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and less than 0.05% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (more than 0% to less than 5%). *For all other springs:* The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be 0% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells (0%).

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
Water Resources, continued				
Deep aquifer springs water quality (R-aquifer)	Impact duration: *More than 5 years.* North Parcel: From no to 11 mines might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels (4.9 µg/L uranium and 2 µg/L arsenic), but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at the Kanab and Showerbath spring complex. If as many as 11 mines contribute impacted water to the R-aquifer, the projected maximum resultant concentration is 14 µg/L for uranium and 4 µg/L for arsenic East Parcel: From no to 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels (1.7 µg/L uranium and 10 µg/L arsenic), but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at the Fence Fault spring complex. If as many as 1 mine contributes impacted water to the R-aquifer, the projected maximum resultant uranium concentration is 1.8 µg/L; resultant maximum arsenic concentration would not be expected to exceed ambient levels. South Parcel: *For Havasu and Blue Springs,* From no to 4 mines might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For the Hermit and Indian Garden spring complexes,* From no to 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels (3 µg/L uranium and 4-10 µg/L arsenic), but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic). Projected maximum resultant uranium concentration is 4 to 5 µg/L if 1 mine contributes impacted water to the R-aquifer; resultant maximum arsenic concentration would not be expected to exceed ambient levels. *For small South Rim springs.* From no to 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels (4 µg/L uranium and 10 µg/L arsenic) and drinking water standards (30 µg/L uranium or 10 µg/L arsenic). Projected maximum resultant concentration is 70 µg/L for uranium and 30 µg/L for arsenic if 1 mine contributes impacted water to the R-aquifer.	Impact duration: *More than 5 years.* North Parcel: From no to 5 mines might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels, but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at the Kanab and Showerbath spring complex. If as many as 5 mines contribute impacted water to the R-aquifer, the projected maximum resultant concentration is 9.0 µg/L for uranium and 3 µg/L for arsenic East Parcel: No mines would contribute impacted water to the R-aquifer. South Parcel: *For Havasu Springs only:* From no to1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For all other springs:* No mines would contribute impacted water to the R-aquifer.	Impact duration: *More than 5 years.* North Parcel: From no to 7 mines might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels, but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at the Kanab and Showerbath spring complex. If as many as 7 mines contribute impacted water to the R-aquifer, the projected maximum resultant concentration is 11 µg/L for uranium and 3 µg/L for arsenic East Parcel: From no to 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels, but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at the Fence Fault spring complex. If as many as 1 mine contributes impacted water to the R-aquifer, the projected maximum uranium resultant concentration is 1.8 µg/L; resultant maximum arsenic concentration would not be expected to exceed ambient levels. South Parcel: *For Havasu Springs only:* From no to 2 mines might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For all other springs:* No mines would contribute impacted water to the R-aquifer.	Impact duration: *More than 5 years.* North Parcel: From no to 10 mines might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels, but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at the Kanab and Showerbath spring complex. If as many as 10 mines contribute impacted water to the R-aquifer, the projected maximum resultant concentration is 13 µg/L for uranium and 3 µg/L for arsenic East Parcel: From no to 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels, but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at the Fence Fault spring complex. If as many as 1 mine contributes impacted water to the R-aquifer, the projected maximum uranium resultant concentration is 1.8 µg/L; resultant maximum arsenic concentration would not be expected to exceed ambient levels. South Parcel: *For Havasu Springs only:* From no to 3 mines might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For all other springs:* No mines would contribute impacted water to the R-aquifer.
Deep aquifer wells water quantity, including Tusayan wells in South Parcel (R-aquifer)	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels in non-mine R-aquifer wells would be expected to range between 0 and 10 feet after 5 years of pumping any single mine well.	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels in non-mine R-aquifer wells would be expected to range between 0 and 10 feet after 5 years of pumping any single mine well.	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels in non-mine R-aquifer wells would be expected to range between 0 and 10 feet after 5 years of pumping any single mine well.	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels in non-mine R-aquifer wells would be expected to range between 0 and 10 feet after 5 years of pumping any single mine well.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
Water Resources, continued				
Deep aquifer wells water quality, including Tusayan wells in South Parcel (R-aquifer)	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.
Surface water quantity	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 13.3% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. Reduction might be large if flow is supported by impacted perched aquifer springs, which have a probability of 1.3% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. South Parcel: *Perennial Streams:* Reduction would not be expected to be detectable where flow is supported by Havasu and Blue Springs. Reduction would range from 0% to more than 10% where flow is supported by South Rim springs. Reduction might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.2% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams*: Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 5.4% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: No water quantity impacts to perched aquifer springs that support surface water flow, and no surface disturbance would occur as a result of mining-related activities. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, reduction would not be expected to be detectable. No reduction would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams*: Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 6.7% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No reduction would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, reduction would not be expected to be detectable. No reduction would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams*: Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 10.8% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No reduction would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, reduction would not be expected to be detectable. No reduction would occur where flow is supported by Blue Springs or South Rim springs. Reduction might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.3% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Water Resources, continued				
Surface water quality, including surface water runoff from active mines	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 13.3% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 1.3% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. South Parcel: *Perennial Streams:* Where flow is supported by Havasu and Blue Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. Where flow is supported by South Rim springs, changes could range from no change to changes that might result in exceedance of drinking water standards. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.2% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 5.4% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: No water quality impacts to perched aquifer or R-aquifer springs that support surface water flow, and no surface disturbance would occur as a result of mining-related activities. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. No changes would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 6.7% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No changes would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. No changes would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 10.8% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No changes would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. No changes would occur where flow is supported by Blue Springs or South Rim springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.3% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas.
Surface water stream function	Impact duration: *1 year to more than 5 years.* All three parcels: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts to stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas.	Impact duration: *1 year to more than 5 years.* North Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas. East Parcel: No surface disturbance would occur as a result of mining-related activities. South Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts on stream morphology and function.	Impact duration: *1 year to more than 5 years.* North Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas. East and South Parcels: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts on stream morphology and function.	Impact duration: *1 year to more than 5 years.* North and South Parcels: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas. East Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
Water Resources, continued				
Virgin River water quantity and quality	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
Colorado River water quantity and quality	Impact duration: *1 year to more than 5 years.* All parcels: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *1 year to more than 5 years.* All parcels: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *1 year to more than 5 years.* All parcels: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *1 year to more than 5 years.* All parcels: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
Soil Resources (4.5)				
Disturbance of soil resources (cumulative impacts discussed in Section 4.5.3)	Impact duration: *More than 5 years all three parcels.* Disturbance acreage: North Parcel, 945 acres; East Parcel, 107 acres; and South Parcel, 312 acres. Disturbance relative to respective parcel area: *≤0.2%.*	Impact duration: *More than 5 years North and South Parcels, No impact East Parcel.* Disturbance acreage: North Parcel, 163 acres; East Parcel, 0 acres; and South Parcel, 1 acre. Disturbance relative to respective parcel area: *≤0.03%.*	Impact duration: *More than 5 years all three parcels.* Disturbance acreage: North Parcel, 320 acres; East Parcel, 54 acres; and South Parcel, 158 acres. Disturbance relative to respective parcel area: *≤0.06%.*	Impact duration: *More than 5 years all three parcels* Disturbance acreage: North Parcel, 668 acres; East Parcel, 54 acres; and South Parcel, 209 acres. Disturbance relative to respective parcel area: *≤0.12%.*
Loss of soil productivity	Area of disturbance: Impact duration: *More than 5 years* Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area. Potential for increased erosion: *All three parcels* Impact duration: *1 to 5 years.* Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances.	Area of disturbance: Impact duration: *1 to 5 years.* Anticipated soil disturbance in each proposed withdrawal parcel would vary from none to less than 1% of the parcel area. Potential for increased erosion: Impact duration: *1 to 5 years.* North Parcel: Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances. East Parcel: Soil erosion would be at the regional baseline soil loss rate. South Parcel: Increased erosion and sedimentation would be expected to be limited to the immediate vicinity of roadways, power lines, drill sites, and mine sites.	Area of disturbance: Impact duration: *More than 5 years* Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area. Potential for increased erosion: Impact duration: *1 to 5 years.* North Parcel: Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances. East and South Parcels: Increased erosion and sedimentation would be expected to be limited to the immediate vicinity of roadways, power lines, drill sites, and mine sites.	Area of disturbance: Impact duration: *More than 5 years* Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area. Potential for increased erosion: Impact duration: *1 to 5 years.* North and South Parcels: Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances. East Parcel: Increased erosion and sedimentation would be expected to be limited to the immediate vicinity of roadways, power lines, drill sites, and mine sites. Increased sensitivity to wind erosion in some areas might result in substantially increased rates of erosion if disturbance occurs in those areas.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Soil Resources (4.5), continued				
Soil contamination	Potential for constituent distribution: Impact duration: *More than 5 years for all three parcels.* Impacts at 30 mine sites (21 in North Parcel, 2 in the East Parcel, and 7 in the South Parcel) could range from: Concentrations of uranium and arsenic in soil would be expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: Concentrations of uranium and arsenic in soil might be generally at or above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites.	Potential for constituent distribution: Impact duration: *More than 5 years* North Parcel: Impacts at 10 mine sites could range from: Concentrations of uranium and arsenic in soil would be expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: Concentrations of uranium and arsenic in soil might be generally at or above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites. East Parcel: Impacts at 0 mine sites would be: Levels of contaminants in soil would be expected to be at background levels. South Parcel: Impacts at 1 mine site would be: Concentrations of uranium and arsenic in soil would be expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites.	Potential for constituent distribution: Impact duration: *More than 5 years* North Parcel: Impacts at 13 mine sites could range from: Concentrations of uranium and arsenic in soil expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: Concentrations of uranium and arsenic in soil might be generally at or above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites. East Parcel and South Parcels: Impacts at 1 mine site in the East Parcel and 4 mine sites in the South Parcel would be: Concentrations of uranium and arsenic in soil would be expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites.	Potential for constituent distribution: Impact duration: *More than 5 years* North and South Parcels: Impacts at 20 mine sites in the North Parcel and 5 mine sites in the South Parcel could range from: Concentrations of uranium and arsenic in soil expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: Concentrations of uranium and arsenic in soil might be generally at or above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites. East Parcel: Impacts at 1 mine site in the East Parcel would be: Concentrations of uranium and arsenic in soil would be expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites.
Vegetation Resources (4.6)				
Disturbance of vegetation	Impact duration: *More than 5 years.* Impacts on vegetation are possible depending on the location of mine facilities. Impacts could vary from changes in overall density and diversity of vegetation resources not being measurable or apparent to being measurable but not apparent. Impacts to density and diversity of aquatic and terrestrial habitats could be measurable but not apparent. Estimated acres of disturbance: 1,432	Impact duration: *More than 5 years.* Impacts to vegetation are expected to not be measurable or apparent Impacts on density and diversity of aquatic and terrestrial habitats are not anticipated to be measurable or apparent. Acres disturbed represent an approximate 88% decrease from Alternative A. Estimated acres of disturbance: 203	Impact duration: *More than 5 years.* Impacts to vegetation are expected to not be measurable or apparent. Impacts on density and diversity of aquatic and terrestrial habitats are not anticipated to be measurable or apparent. Acres disturbed represent an approximate 61% decrease from Alternative A. Estimated acres of disturbance: 604	Impact duration: *More than 5 years.* Impacts on vegetation are possible depending on the location of mine facilities. Impacts could vary from changes in overall density and diversity of vegetation resources not being measurable or apparent to being measurable but not apparent. Impacts to density and diversity of aquatic and terrestrial habitats could be measurable but not apparent. Acres disturbed represent an approximate 30% decrease from Alternative A. Estimated acres of disturbance: 1,065
Vegetation productivity	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.
Fish and Wildlife Resources (4.7)				
Wildlife habitat (aquatic and terrestrial habitats)	Impact duration: *More than 5 years.* Impacts on aquatic and terrestrial habitats are anticipated and would depend on the location of mines. Overall water quality and quantity impacts on area seeps, springs, and other water bodies could vary from not being measurable or apparent to measurable and apparent.	Impact duration: *More than 5 years.* Impacts are anticipated on aquatic and terrestrial habitats and on overall water quality and quantity impacts of area seeps, springs, and other water bodies. These impacts are not anticipated to be measurable or apparent. Acres disturbed represents an approximate 88% decrease from Alternative A.	Impact duration: *More than 5 years.* Impacts are anticipated on aquatic and terrestrial habitats and on overall water quality and quantity impacts of area seeps, springs, and other water bodies. These impacts are not anticipated to be measurable or apparent. Acres disturbed represents an approximate 61% decrease from Alternative A.	Impact duration: *More than 5 years.* Impacts on aquatic and terrestrial habitats are anticipated and depend on the location of mines. Overall water quality and quantity impacts of area seeps, springs, and other water bodies are anticipated to be measurable but not apparent. Acres disturbed represents an approximate 30% decrease from Alternative A.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
Fish and Wildlife Resources (4.7), continued				
Chemical and radiation impacts	Impact duration: *More than 5 years.* Uranium and its decay constituents may impact individual animals (including possible mortality); impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts in the vicinity of sensitive aquatic and terrestrial habitats, such as Kanab Creek Canyon, are afforded greater protection under Alternative B than under Alternative A. Increases may impact individuals (including possible mortality); impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Alternative C affords greater protection than Alternative A. Reductions in aquatic and terrestrial habitat quality and quantity may impact individuals (including possible mortality); impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts are anticipated to be reduced in the vicinity of sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative D affords greater protection than Alternative A. Reductions in aquatic and terrestrial habitat quality and quantity may impact individuals (including possible mortality); however, impacts are not anticipated to alter overall fish and wildlife populations.
Habitat fragmentation	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated. Magnitude would depend on the location of mines and on the magnitude of water quality and quantity impacts on area seeps, springs, and other water bodies due to mining. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated. Magnitude would depend on the location of mines and on the magnitude of water quality and quantity impacts on area seeps, springs, and other water bodies due to mining. Impacts near sensitive aquatic and terrestrial habitats, such as Kanab Creek, are afforded greater protection under Alternative B than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts would not be measurable or apparent and are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter overall fish and wildlife populations.
Special Status Species (4.8)				
Special status species habitat (aquatic and terrestrial habitats)	Impact duration: *More than 5 years.* Magnitude would depend on the location of exploration activities and mine operations and on the amount of ground disturbance, magnitude of impacts on water quality and quantity of area seeps and springs, and other water bodies due to mining.Impacts to habitats could vary from effects to individual animals and effects to habitat that are neither measurable nor detectable, to having effect on individuals and have the potential to be both measurable and apparent.	Impact duration: *More than 5 years.* Magnitude would depend on the location of exploration activities and mine operations and on the amount of ground disturbance, magnitude of impacts on water quality and quantity of area seeps and springs, and other water bodies due to mining. Impacts on both aquatic and terrestrial habitats and impacts and on water quality and quantity of seeps, springs, and other water bodies are anticipated; however, these impacts are not anticipated to be measurable or apparent. Acres disturbed represents an 88% decrease, compared with Alternative A.	Impact duration: *More than 5 years.* Magnitude would depend on the location of exploration activities and mine operations and on the amount of ground disturbance, magnitude of impacts on water quality and quantity of area seeps and springs, and other water bodies due to mining. Impacts on both aquatic and terrestrial habitats are anticipated; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. However, these impacts are not anticipated to be measurable or apparent. Acres disturbed represents a 61% decrease, compared with Alternative A.	Impact duration: *More than 5 years.* Magnitude would depend on the location of exploration activities and mine operations and on the amount of ground disturbance, magnitude of impacts on water quality and quantity of area seeps and springs, and other water bodies due to mining. Impacts on both aquatic and terrestrial habitats are anticipated; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies; however, these impacts are anticipated to be measurable but not apparent. Acres disturbed represents a 30% decrease, compared with Alternative A.
Chemical and radiation impacts	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soil are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations.	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soils are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations. Impacts near sensitive aquatic and terrestrial habitats, such as Kanab Creek, are afforded greater protection under Alternative B than Alternative A.	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soils are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations. Because approximately 2/3 of the proposed withdrawal area would be withdrawn, impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A.	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soils are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations. Because approximately1/3 of the proposed withdrawal area would be withdrawn, impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative D affords greater protection than Alternative A.
Habitat fragmentation	Impact duration: *More than 5 years.* Impacts on unfragmented habitat (acres) are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of a mine and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Increased fragmentation may impact individuals (including possible mortality); however, impacts are not anticipated to alter populations of special status fish and wildlife species.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of the mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts near sensitive aquatic and terrestrial habitats, such as Kanab Creek are afforded greater protection under Alternative B than Alternative A. Increased fragmentation may impact individuals (including possible mortality); however, impacts are not anticipated to alter populations of special status fish and wildlife species.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter populations of special status fish and wildlife species.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat (acres) are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative D affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); however, impacts are not anticipated to alter populations of special status fish and wildlife species.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
Visual Resources (4.9)				
Conformance with BLM Visual Resource Management class objectives	Impact duration: *More than 5 years.* No withdrawal of sensitive visual designations: Class I, Class II, Preservation, High. Degrees of contrast and impact vary and are specific to each mining project and from each viewpoint. Impacts could vary from: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer To: Project-related impacts would create a high degree of change within the existing landscape, would dominate the view, and would be a focus of viewer attention (this will be reduced upon completion of reclamation).	Impact duration: *More than 5 years.* Withdrawal of all sensitive visual designations: Class I, Class II, Preservation, High. Would not produce obvious changes in landscape contrasts.	Impact duration: *More than 5 years.* Withdrawal of approximately 88% of sensitive visual designations: Class I, Class II, Preservation, High. Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer.	Impact duration: *More than 5 years.* Withdrawal of approximately 53% of sensitive visual designations: Class I, Class II, Preservation, High. Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer.
Conformance with Forest Service visual objectives	Impact duration: *From 1 to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer To: Project-related impacts would create a high degree of change within the existing landscape, would dominate the view, and would be a focus of viewer attention (this will be reduced upon completion of reclamation).	Impact duration: *From less than 1 year to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer. To: Visual impacts that would partially retain the existing character of the landscape, and while attracting the attention of the casual viewer, would not dominate the view.	Impact duration: *From less than 1 year to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer. To: Visual impacts that would partially retain the existing character of the landscape, and while attracting the attention of the casual viewer, would not dominate the view.	Impact duration: *From 1 to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. From: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer. To: Project-related impacts would create a high degree of change within the existing landscape, would dominate the view, and would be a focus of viewer attention (this will be reduced upon completion of reclamation).
Conformance with Park visual objectives from key observation points	Impact duration: *More than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer. To: Visual impacts that would partially retain the existing character of the landscape, and while attracting the attention of the casual viewer, would not dominate the view.	Impact duration: *More than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Would not produce obvious changes in landscape contrasts. To: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer.	Impact duration: *More than 5 years* Degrees of contrast and impact vary and are specific to each viewpoint. Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer.	Impact duration: *More than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer. To: Visual impacts that would partially retain the existing character of the landscape, and while attracting the attention of the casual viewer, would not dominate the view.
Changes in night sky	Impact duration: *More than 5 years* Given the quality of the dark night skies in the area, minimal increases in night lighting could impact the areas night skies. With mitigation, impacts to the area's night sky would be minimal. Impacts could occur to casual observers in the vicinity of the mines and exploration sites, persons traveling along area roads at night, and recreationists camping in the area.	Impact duration: *More than 5 years.* Reduction in projected mining and associated activities as compared to Alternative A would result in decreased visual impacts to the night sky.	Impact duration: *More than 5 years.* Reduction in projected mining and associated activities as compared to Alternative A would result in decreased visual impacts to the night sky.	Impact duration: *More than 5 years.* There is some reduction in projected mining and associated activities as compared to Alternative A that would result in some decreased visual impacts to the night sky.
Soundscapes (4.10)				
Noise disruption from exploration or development activity	Impacts to soundscapes are dependent on mine and haul road locations. If mines or roads are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.	Impacts to soundscapes are dependent on mine and haul road locations. If they are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.	Impacts to soundscapes are dependent on mine and haul road locations. If they are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.	Impacts to soundscapes are dependent on mine and haul road locations. If they are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
Cultural Resources (4.11)				
Disturbance of historic and prehistoric sites	Impact duration: *Exceeds 5 years* 2,535 known sites, as well as undiscovered sites, are located in areas subject to direct and indirect impacts from three existing mines and a projected number of 26 new mines and 728 exploration projects that would disturb 1,364 acres. Assessment of impacts would require site-specific analysis. Direct impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.	Impact duration: *Exceeds 5 years* 2,535 known sites are in areas withdrawn from new mining claims and exploration. Sites would be subject to direct and indirect impacts limited to development of valid existing claims. Projected development includes 11 new mines and 11 exploration projects that would disturb 164 acres. Impacts would be largely in the North Parcel, with no new mining or exploration in the East Parcel and a single mine in the South Parcel. Assessment of impacts would require site-specific analysis. Direct adverse impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.	Impact duration: *Exceeds 5 years* 1,898 known sites in the proposed withdrawal area would be subject to direct and indirect impacts limited to development of valid existing claims. 637 sites outside the withdrawn areas would also be subject to impacts from new exploration activities, claims, and mines. Projected development includes 18 mines and 207 exploration projects that would disturb 532 acres. The proposed withdrawn areas include zones known to have high densities of important cultural resources. Assessment of impacts would require site-specific analysis. Direct adverse impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.	Impact duration: *Exceeds 5 years* 1,105 known sites in the proposed withdrawal area would be subject to direct and indirect impacts limited to development of valid existing claims. 1,430 sites outside the withdrawn areas would also be subject to impacts from new exploration activities, claims, and mines. Projected development includes 26 mines and 431 exploration projects that would disturb 951 acres. Assessment of impacts would require site-specific analysis. Direct adverse impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.
American Indian Resources (4.12)				
Effect on Known Traditional Cultural Properties or Places (TCPs)	Impact duration: *More than 5 years* Mining-related impacts would result in loss of resource and/or functional use of resource such as Red Butte and other TCPs.	Impact duration: *More than 5 years* Would avoid adverse effects on Red Butte and other TCPs.	Impact duration: *More than 5 years* Would avoid adverse effects on Red Butte and other TCPs.	Impact duration: *More than 5 years* Mining-related impacts would result in loss of resource and/or functional use of resource such as Red Butte and other TCPs.
Disturbance of places of traditional cultural practices and uses	Types of known resources in proposed for withdrawal: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, camps, and traditional use plants and animals. *All three parcels:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Long-term direct impacts* *Visual and auditory (indirect) impacts:* Impact duration: *1 to 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Short-term* *Visual impacts from power lines:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.	Types of known resources in the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, camps, and traditional use plants and animals. *North Parcel primarily in area along Kanab Creek.* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Long-term direct impacts.* *East Parcel:* Would avoid resource. *South Parcel:* Impact duration: *More than 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual and auditory (indirect) impacts on North and South parcels:* Impact duration: *1 to 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual impacts from power lines on North and South parcels:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.	Types of known resources in the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, camps, and traditional use plants and animals. Types of known resources outside the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, camps, and traditional use plants and animals. *North Parcel primarily in area along Kanab Creek.* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *East Parcel in area excluded for withdrawal:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Long term* *South Parcel:* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual and auditory (indirect) impacts on all three parcels:* Impact duration: *More than 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual impacts from power lines on North and East parcels*: Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.	Types of known resources in the proposed withdrawal area: landscapes, trails, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, camps, and traditional use plants and animals. Types of known resources outside the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, camps, and traditional use plants and animals. *All three parcels since the majority of resources would be outside the withdrawal boundaries:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Visual and auditory (indirect) impacts:* Impact duration: *1 to 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual impacts from power lines:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
American Indian Resources (4.12), continued				
Protection of tribal trust resources or assets	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*
Wilderness (4.13)				
Designated wilderness	Changes to wilderness resources: No discernible effect on designated wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. Impact duration: *1 to 5 years* Greatest amount of mineral activity estimated; highest risk of impacts to wilderness resources. *Impacts could vary from:* Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. While there might be short-term indirect impacts within the wilderness, over the long-term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season. To: Impacts would be readily apparent within limited areas of the wilderness that are adjacent or very proximate to mineral activity. It would be apparent that man has altered natural conditions within such areas. There would be no mining related development within wilderness. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted in limited areas and during limited times of the year.	Changes to wilderness resources: No discernible direct effect on designated wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. The decrease in mining-related activity under Alternative B would result in an indirect but beneficial impact to wilderness resources when compared to Alternative A. Impact duration: *1 to 5 years* Least amount of mineral activity; lowest risk for impacts to wilderness resources. Indirect impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining-related development within wilderness. While there might be short-term indirect impacts within the wilderness in areas that are adjacent or very proximate to mineral activity, over the long-term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.	Changes to wilderness resources: No discernible direct effect on designated wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. The decrease in mining-related activity under Alternative C would result in an indirect but beneficial impact to wilderness resources when compared to Alternative A. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts to wilderness resources. Indirect impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. While there might be short-term impacts within the wilderness in areas that are adjacent or very proximate to mineral activity, over the long-term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.	Changes to wilderness resources: No discernible direct effect on designated wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. The decrease in mining-related activity under Alternative D would result in an indirect but beneficial impact to wilderness resources when compared to Alternative A. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts to wilderness resources. Indirect impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. While there might be short-term impacts within the wilderness in areas that are adjacent or very proximate to mineral activity, over the long-term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.
NPS proposed wilderness	Changes to wilderness resources: No discernible effect on proposed wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Most mineral activity estimated; highest risk of impacts to proposed wilderness. *Impacts could vary from:* Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. While there might be short-term indirect impacts within the proposed wilderness, over the long-term, Outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season. To: Impacts would be readily apparent within limited areas of the proposed wilderness that are adjacent or very proximate to mineral activity. It would be apparent that man has altered natural conditions within such areas. There would be no mining related development within the proposed wilderness. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted in limited areas and during limited times of the year.	Changes to wilderness resources: No discernible effect on proposed wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Least amount of mineral activity; lowest risk for impacts to proposed wilderness. Impacts would be slightly detectable within limited areas of the proposed wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. While there might be short-term indirect impacts within the proposed wilderness, over the long-term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.	Changes to wilderness resources: No discernible effect on proposed wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts to proposed wilderness. Impacts would be slightly detectable within limited areas of the proposed wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. While there might be short-term indirect impacts within the proposed wilderness, over the long-term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.	Changes to wilderness resources: No discernible effect on proposed wilderness areas' character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts to proposed wilderness. Impacts would be slightly detectable within limited areas of the proposed wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. While there might be short-term indirect impacts within the proposed wilderness, over the long-term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Wilderness Characteristics (4.14)				
Lands possessing or managed to maintain wilderness characteristics	Impact duration: *More than 5 years* Changes in the land's wilderness characteristics: Greatest amount of mineral activity estimated since a withdrawal would not occur; highest risk of impacts on wilderness characteristics. Moderate and long-term adverse effect on lands managed to maintain wilderness characteristics. Site-specific diminution of naturalness, outstanding opportunities for solitude and outstanding opportunities for a primitive and unconfined type of recreation would occur. However, natural conditions of the lands managed to maintain wilderness characteristics would prevail in areas far removed from mining activity.	Impact duration: *1 to 5 years* Changes in the land's wilderness characteristics: Least amount of mineral activity anticipated to occur; lowest risk for impacts on wilderness characteristics. The decrease in mining-related activity under Alternative B would result in an indirect but beneficial impact to wilderness characteristics when compared to Alternative A. Moderate and long-term beneficial effect to lands managed to maintain wilderness characteristics. Site-specific diminutions to naturalness, outstanding opportunities for solitude, and outstanding opportunities for a primitive and unconfined type of recreation would only occur at valid existing rights. Current conditions of the lands managed to maintain wilderness characteristics would be maintained.	Impact duration: *1 to 5 years* Changes in the land's wilderness characteristics: Less mineral activity than Alternative A anticipated to occur; less risk for impacts to wilderness characteristics. The decrease in mining-related activity under Alternative C would result in an indirect but beneficial impact to wilderness characteristics when compared to Alternative A. Minor and long-term adverse effect on lands managed to maintain wilderness characteristics. Site-specific diminution of naturalness, outstanding opportunities for solitude, and outstanding opportunities for a primitive and unconfined type of recreation would occur. However, natural conditions of the lands managed to maintain wilderness characteristics would prevail in areas far removed from mining activity.	Impact duration: *1 to 5 years* Changes in the land's wilderness characteristics: Less mineral activity than Alternative A anticipated to occur; less risk for impacts on wilderness characteristics. The decrease in mining-related activity under Alternative D would result in an indirect but beneficial impact to wilderness characteristics when compared to Alternative A. Minor and long-term adverse effect on lands managed to maintain wilderness characteristics. Site-specific diminution of naturalness, outstanding opportunities for solitude, and outstanding opportunities for a primitive and unconfined type of recreation would occur. However, natural conditions of the lands managed to maintain wilderness characteristics would prevail in areas far removed from mining activity.
Recreation Resources (4.15)				
Visitor use	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would be: Changes to the existing character of the recreation setting resultant from a no-withdrawal scenario; these changes and would not dominate the recreation opportunity for the desired recreation experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along SR 64: A no-withdrawal scenario would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would experience: The proposed mineral withdrawal under Alternative B would retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along SR 64: The proposed mineral withdrawal under Alternative B would retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would be: The proposed mineral withdrawal under Alternative C would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along SR 64: The proposed mineral withdrawal under Alternative C would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would be: The proposed mineral withdrawal under Alternative D would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along SR 64: The proposed mineral withdrawal under Alternative D would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.
Roads and access	Impact duration: *More than 5 years* The 22.4 miles of new mining-related roads that would be included in a no-withdrawal scenario would benefit driving for pleasure and would increase the road density more than the other alternatives. Impact would be: Changes to the existing character of the recreation setting, and may dominate the recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* The 6.4 miles of new mining-related roads that would be included in Alternative B's withdrawal scenario would benefit driving for pleasure and would increase the existing road density the least of the 4 alternatives. Impact would be: Retaining the existing character of the recreation setting; the valid existing rights and existing mineral activity would create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The 12.1 miles of new mining-related roads that would be included in Alternative C's withdrawal scenario would benefit driving for pleasure. Impact would be: Partial retention of the existing character of the recreation setting; the valid existing rights and existing mineral activity would create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The 19.1 miles of new mining-related roads that would be included in Alternative D's withdrawal scenario would benefit driving for pleasure and would increase the road density more than any other action alternative, but less than alternative A. Impact would be: Partial retention of the existing character of the recreation setting; the valid existing rights and existing mineral activity would create a low level of change in the recreation opportunity or desired experiences.
Primitive recreation opportunity	Impact duration: *More than 5 years* A no-withdrawal scenario would include of 22.4 miles of new roads that could adversely impact users seeking primitive recreation opportunities in adjacent areas. No primitive settings occur within the Alternative A area. Impacts from a no-withdrawal scenario would partially retain the existing character of the recreation setting, and may dominate the primitive recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* The increase of 6.4 miles of roads that would be included in Alternative B's withdrawal scenario could adversely impact users seeking primitive recreation opportunities in adjacent areas, although minimally. No primitive settings occur within the Alternative B proposed withdrawal area. The decrease in mining-related activity under Alternative B would result in an indirect but beneficial impact to primitive recreation opportunities when compared to Alternative A. Impacts from existing mineral activity and valid existing rights would retain the existing character of the recreation setting and create a low level of change in the primitive recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The increase of 12.1 miles of roads that would be included in Alternative C's withdrawal scenario could adversely impact users seeking primitive recreation opportunities in adjacent areas, although minimally. No primitive settings occur within the Alternative C proposed withdrawal area. The decrease in mining-related activity under Alternative C would result in an indirect but beneficial impact to primitive recreation opportunity when compared to Alternative A. Impacts from existing mineral activity and valid existing rights would retain the existing character of the recreation setting and create a low level of change in the primitive recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The increase of 19.1 miles of roads that would be included in Alternative D's withdrawal scenario could adversely impact users seeking primitive recreation opportunities in adjacent areas. No primitive settings occur within the Alternative D proposed withdrawal area. The decrease in mining-related activity under Alternative D would result in an indirect but beneficial impact to recreation opportunity when compared to Alternative A. Impacts from existing mineral activity and valid existing rights would retain the existing character of the recreation setting and create a moderate level of change in the primitive recreation opportunity or desired experiences.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Preferred Alternative Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 Acres Withdrawn)	Alternative D Partial Withdrawal 20 Years (~300,000 Acres Withdrawn)
Social Conditions (4.16)				
Demographics	Impact duration: *More than 5 years* Population increase is estimated to be 520 individuals, over a six-county area. Overall, the increase in population would not produce obvious changes in demographics since the population change would be a very small percentage of the total population in the six-county area (0.002%). The effect in Fredonia, Colorado City, and Kanab could be amplified as their populations may increase by about 10.52%, 2.87%, and 3.21% respectively.	Impact duration: *More than 5 years* Estimated population changes for Alternative B are 73% less than for Alternative A. Alternative B includes a potential “loss” of 380 individuals who might otherwise relocate to the study area under Alternative A.	Impact duration: *More than 5 years* Estimated population changes for Alternative C are 46% less than for Alternative A. Alternative C includes a potential “loss” of 240 individuals who might otherwise relocate to the study area under Alternative A.	Impact duration: *More than 5 years* Estimated population changes for Alternative D are 16% less than for Alternative A. Alternative D includes a potential “loss” of 85 individuals who might otherwise relocate to the study area under Alternative A.
Stakeholder values–mineral activity support	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; most gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Would retain the existing character of the stakeholder values, but would create a low level of change which would not alter the perception of the Grand Canyon region for stakeholders (either residents or visitors).	Impact duration: *More than 5 years* Least amount of mineral activity; fewer gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Impacts on social conditions that would adversely affect stakeholders, but can be mitigated.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Impacts on social conditions that would adversely affect stakeholders, but can be mitigated.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Impacts on social conditions that would adversely affect stakeholders, but can be mitigated.
Stakeholder values–withdrawal support	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; greatest amount of impacts for individuals and communities who support withdrawal. Impact is expected to be: Alternative A would result in the most considerable adverse direct and indirect impacts to individuals and groups who would like to see mineral activity prohibited in the areas proposed for withdrawal.	Impact duration: *More than 5 years* Least amount of mineral activity; less severe impacts for individuals and communities who support withdrawal. Impact is expected to be: Alternative B includes some mineral activity (primarily in the North Parcel); however, less estimated activity than under Alternative A so individuals and groups who support mineral withdrawal would be more (positively) impacted.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer impacts for individuals and communities who support withdrawal. Impact is expected to be: Alternative C includes some mineral activity (concentrated in the North Parcel); however, less estimated activity than under Alternative A. Individuals and groups who support mineral withdrawal would be more (positively) impacted than in Alternatives A or D, but less than B.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer impacts for individuals and communities who support withdrawal. Impact is expected to be: Alternative D includes a similar level of mineral activity (concentrated in the North Parcel); however, less estimated activity than under Alternative A. Individuals and groups who support mineral withdrawal would be more (positively) impacted than Alt A, but less than B or C.
Health safety risks	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; highest risk of health impacts, although health risks are not expected to elevate above current conditions. Would retain the existing character of the public health and safety, but would create a low level of change.	Impact duration: *More than 5 years* Least amount of mineral activity; lowest risk for health impacts. Would not produce obvious changes in public health and safety.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; less risk for health impacts. Would not produce obvious changes in public health and safety, although it may be greater than Alternative B.	Impact duration: *More than 5 years* Less mineral activity than Alternative A, although more similar than other alternatives; less risk for health impacts. Would retain the existing character of the public health and safety, but would create a low level of change.
Human safety risks	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; highest risk of human safety impacts on conditions that would adversely affect stakeholders, but can be mitigated.	Impact duration: *More than 5 years* Least amount of mineral activity; lowest risk for human safety impacts. Would not produce obvious changes in public health and safety.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; less risk for human safety impacts. Would retain the existing character of the public health and safety, but would create a low level of change.	Impact duration: *More than 5 years* Less mineral activity than Alternative A, although more similar than other alternatives; some risk of human safety impacts on conditions that would adversely affect stakeholders, but can be mitigated.
Environmental justice	Impact duration: *More than 5 years* Ten communities, including five tribes in the analysis area, meet the criteria for consideration under environmental justice rules. Alternative A would result in the highest risk of human health impacts for environmental justice communities.	Impact duration: *More than 5 years* Ten communities including five tribes in the analysis area meet EPA criteria for consideration under environmental justice rules. Conditions create a low level of change but no measurable impacts to identified groups.	Impact duration: *More than 5 years* Ten communities including five tribes in the analysis area meet EPA criteria for consideration under environmental justice rules. Conditions create a low level of change but no measurable impacts to identified groups.	Impact duration: *More than 5 years* Ten communities including five tribes in the analysis area meet EPA criteria for consideration under environmental justice rules. Alternative D would result in the a similarly higher risk of human health impacts for environmental justice communities, as described for Alternative A.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (Continued)

Resource Category/ Issue	**Alternative A** **No Action** **Area Remains Open under the Mining Law**	**Alternative B** **Preferred Alternative** **Proposed Action** **20 Years** **(~1 Million Acres Withdrawn)**	**Alternative C** **Partial Withdrawal** **20 Years** **(~650,000 Acres Withdrawn)**	**Alternative D** **Partial Withdrawal** **20 Years** **(~300,000 Acres Withdrawn)**
Economic Conditions (4.17)				
Regional Economic Effects	Impact duration: *More than 5 years* North Parcel: Average annual direct mining employment of 235 jobs. Total annual mining-related employment of 513 jobs. Regional employment increase of less than 1%, increase in gross regional product of almost 3%. Larger relative effects in small communities proximate to proposed north withdrawal area. Minor effect on tourism-related economy. South Parcel: Average annual direct mining employment of 60 jobs. Total annual mining-related employment of 123 jobs. Regional employment increase of less than 0.1%, increase in gross regional product of less than 0.3%. No effect to minor effect on tourism-related economy.	Impact duration: *More than 5 years* North Parcel: Decrease in average annual direct mining employment of 162 jobs and 354 total jobs including multiplier effects. Regional employment decrease of about 0.4%, decrease in gross regional product of about 2%. Larger relative effects in small communities proximate to proposed north withdrawal area. Minor benefit for tourism-related economy. South Parcel: Decrease in average annual direct mining employment of 54 jobs and 111 jobs including multiplier effects. Less than 0.1% decrease in regional employment and less than 0.3% reduction in gross regional product. Minor benefit for tourism-related economy.	Impact duration: *More than 5 years* North Parcel: Decrease in average annual direct mining employment of 108 jobs and 236 total jobs including multiplier effects. Regional employment decrease of about 0.3%, decrease in gross regional product of about 1.4%. Larger relative effects in small communities proximate to proposed north withdrawal area. Minor benefit for tourism-related economy. South Parcel: Decrease in average annual direct mining employment of 28 jobs and 58 jobs including multiplier effects. About 0.04% decrease in regional employment and about 0.14% reduction in gross regional product. Minor benefit for tourism-related economy.	Impact duration: *More than 5 years* North Parcel: Decrease in average annual direct mining employment of 30 jobs and 65 total jobs including multiplier effects. Regional employment decrease of less than 0.1%, decrease in gross regional product of less than 0.4%. Larger relative effects in small communities proximate to proposed north withdrawal area. Minor benefit for tourism-related economy. South Parcel: Decrease in average annual direct mining employment of 19 jobs and 39 jobs including multiplier effects. Less than 0.03% decrease in regional employment and less than 0.1% reduction in gross regional product. Minor benefit for tourism-related economy.
Fiscal Effects	Impact duration: *More than 5 years* North Parcel: Increase in annual revenues to federal government of $8.9 million, $5.1 million to state governments, $5.0 million to local governments. South Parcel: Increase in annual revenues to federal government of $1.7 million, $1.0 million to state government, $1.2 million to local governments.	Impact duration: *More than 5 years* North Parcel: Reductions in annual revenues to federal government of $6.1 million, $3.5 million to state governments and $3.5 million to local governments. South Parcel: Reductions in annual revenues to federal government of $1.53 million, $0.92 million to state government and $1.09 million to local governments.	Impact duration: *More than 5 years* North Parcel: Reductions in annual revenues to federal government of $4.0 million, $2.3 million to state governments and $2.3 million to local governments. South Parcel: Reductions in annual revenues to federal government of $0.8 million, $0.5 million to state government and $0.6 million to local governments.	Impact duration: *More than 5 years* North Parcel: Reductions in annual revenues to federal government of $1.1 million, $0.5 million to state governments and $0.6 million to local governments. South Parcel: Reductions in annual revenues to federal government of $0.5 million, $0.4 million to state government and $0.4 million to local governments.
Recreation / Environmental Economics	Impact duration: *More than 5 years* Potential minor effect on economic benefits of recreation. No measurable effects on hunting benefits. Effects on existence value and value of ecosystem services at Grand Canyon National Park cannot be quantified.	Impact duration: *More than 5 years* Minor positive effect for economic benefits of recreation. No effects on hunting benefits. Effects on existence value and value of ecosystem services at Grand Canyon National Park cannot be quantified.	Impact duration: *More than 5 years* Minor positive effect for economic benefits of recreation. No effects on hunting benefits. Effects on existence value and value of ecosystem services at Grand Canyon National Park cannot be quantified.	Impact duration: *More than 5 years* Minor positive effect for economic benefits of recreation. No effects on hunting benefits. Effects on existence value and value of ecosystem services at Grand Canyon National Park cannot be quantified.
Energy Resources	Impact duration: *More than 5 years* Uranium production could meet 8% of current U.S. demand and increase domestic production to 17% of current demand.	Impact duration: *More than 5 years* Reduction in uranium production equivalent to 6% of current U.S. demand.	Impact duration: *More than 5 years* Reduction in uranium production equivalent to 4% of current U.S. demand.	Impact duration: *More than 5 years* Reduction in uranium production equivalent to 2% of current U.S. demand.
Road Condition and Maintenance	Impact duration: *More than 5 years* Maximum traffic increase on public highways of 2.09% to 3.55%.	Impact duration: *More than 5 years* Maximum traffic increase on public highways of 0.93% to 1.59%.	Impact duration: *More than 5 years* Maximum traffic increase on public highways of 1.25% to 2.00%.	Impact duration: *More than 5 years* Maximum traffic increase on public highways of 1.98% to 3.37%.

Chapter 3

AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter describes the affected environment, with a focus on the existing resources and uses that could be affected by the Proposed Action and alternatives presented in Chapter 2. The affected environment is the baseline against which the impacts that may result from mining exploration and development under each of the alternatives is evaluated in Chapter 4. The affected environment description will vary by resource and is not confined to the proposed withdrawal area for all resources or issues. For example, air quality and water quality issues necessitate describing a large area to account for potential downwind or downstream concerns, whereas addressing issues associated with a specific plant species may be limited to a very discrete location within the proposed withdrawal area.

The affected environment is presented by first profiling the physical setting and conditions, followed by describing the biological resources, and culminating with a description of those uses and resources related to human activities. A systematic, comprehensive approach such as this better reveals the relationships that make up the human environment, both in terms of the natural and physical environment and the relationship of people to that environment [40 CFR 1508.14].

The affected environment discussed in this chapter is divided into sections covering the following: air quality and climate; geology and mineral resources; water resources; soil resources; biological resources, including vegetation, wildlife, and special status species; visual resources; soundscapes; cultural resources; American Indian resources; wilderness resources; recreation resources; and social and economic conditions, including environmental justice and public health and safety. Relevant environmental conditions and human uses in the study area have been identified and described using geographic information system (GIS) data, literature searches, electronic searches, interviews, and information provided by the BLM, Forest Service, NPS, USGS, USFWS, other federal and state agency managers and resource specialists, tribal representatives, county officials, and other sources as identified in this chapter and in Chapter 6, Literature Cited.

For each resource category, the relevant issues from Chapter 1 are presented in Table 3.1-1, along with one or more “resource condition indicators.” These resource condition indicators have been developed to provide an issue-focused analysis of potential impacts from the proposed withdrawal or alternatives, which will be presented in Chapter 4. The information presented in Chapter 3 does not describe impacts, but rather describes the existing environment with an emphasis on the present value of these resource condition indicators.

3.1.1 General Setting

The BLM manages public lands under the authority of the Federal Land Policy and Management Act of 1976 [43 USC 1701–1787]. FLPMA provides direction for land use planning, administration, range management, rights-of-way, designated management areas, and prevention of unnecessary or undue degradation.

The Forest Service manages federal lands under the authority of the National Forest Management Act of 1976, which restructured and amended the Forest and Rangeland Renewable Resources Planning Act of 1974. NFMA requires the Secretary of Agriculture to assess National Forest System lands, develop a management program based on multiple-use, sustained-yield principles, and implement a management plan for each unit of the Forest Service.

3.1.2 Areas of Critical Environmental Concern

The BLM portions of the proposed withdrawal (North and East parcels) contain administratively designated areas known as ACECs. ACECs contain one or more resources that require special management and protection to maintain the value(s) of the area and its resources. ACECs may contain important cultural or scenic values, special status species, and/or habitat for these species. ACECs are not closed to mineral entry, but all mining activities above casual use require a plan of operations.

There are three ACECs within the North Parcel: Johnson Springs, Kanab Creek, and Moonshine Ridge. There is one ACEC in the East Parcel: Marble Canyon. There are no ACECs in the South Parcel, as these lands are managed by the Forest Service.

Johnson Springs ACEC was designated to protect cultural resources and the threatened Siler pincushion cactus. The ACEC encompasses 3,444 acres; the southern portion of the ACEC is within the North Parcel.

Kanab Creek ACEC was designated for protection of cultural values, the endangered southwestern willow flycatcher (*Empidonax traillii extimus*), and riparian areas. This ACEC encompasses 13,148 acres and is located entirely within the North Parcel.

Moonshine Ridge ACEC was designated to protect cultural resources and the threatened Siler pincushion cactus (*Pediocactus sileri*). The ACEC encompasses 9,310 acres and is located entirely within the North Parcel.

Marble Canyon ACEC was designated to protect cultural resources and the endangered Brady pincushion (*Pediocactus bradyi*) cactus. The ACEC encompasses 11,797 acres and is located entirely within the East Parcel.

Information on the values for which these ACECs were designated is presented later in this chapter.

3.1.3 National Monuments

There are two national monuments adjacent to the proposed withdrawal area: Grand Canyon–Parashant National Monument is adjacent to the North Parcel, and Vermilion Cliffs National Monument is adjacent to the East Parcel.

Grand Canyon–Parashant National Monument: This monument is jointly managed by the BLM and NPS. The monument encompasses more than 1 million acres of remote and unspoiled public lands. It was designated to protect biological, historical, and archaeological resources.

Vermilion Cliffs National Monument: This monument is managed by the BLM. The monument encompasses 294,000 acres. It was designated to protect unique geological resources such as the Paria Plateau, Vermilion Cliffs, Coyote Buttes, and Paria Canyon. The Vermilion Cliffs National Monument is closed to mineral entry under the 1872 Mining Law.

Upon designation, lands within both monuments were withdrawn from location, entry, and patent under the mining laws, subject to valid existing rights. No active mining claims currently exist in either monument, but non-federal mineral estate is not subject to that withdrawal.

3.1.4 Grand Canyon National Park

Grand Canyon National Park is adjacent to each of the proposed withdrawal parcels. Although first afforded federal protection in 1893 as a Forest Reserve and later as a National Monument, Grand Canyon did not achieve National Park status until 1919, three years after the creation of the NPS. Grand Canyon National Park is a world heritage site and an international icon. The Park is dominated by the Grand Canyon (or Canyon), a twisting, 1-mile deep, 277-mile-long gorge formed during some 6 million years of geological activity and erosion by the Colorado River on the upraised earth's crust. The river divides the Park into the North and South rims, which overlook the approximately 10-mile-wide canyon. Grand Canyon National Park encompasses 1,217,403.32 acres (NPS 1995). The Park is closed to mineral entry under the 1872 Mining Law.

3.1.5 Game Preserves

In 1906, President Theodore Roosevelt established the Grand Canyon National Game Preserve, generally located between the North and East parcels on the Kaibab Plateau (although a small portion of the preserve does extend into the northern areas of the South parcel). The reason for establishment of the preserve was concerns about the extirpation of game species through unregulated hunting. The preserve is managed by the Forest Service in accordance with the Kaibab LRMP/ROD (Forest Service 1988). The Grand Canyon Game Preserve is closed to mineral entry. More information on the Grand Canyon Game Preserve can be found in Section 3.7, Fish and Wildlife.

3.1.6 Indian Reservations

Navajo Nation

The Navajo Reservation was formed under the Navajo Treaty of 1868, and extends into the states of Utah, Arizona, and New Mexico. The reservation encompasses 27,635 square miles; the portion located in Arizona covers 11.6 million acres. While the lands of the Navajo Nation are not contiguous but "checker-boarded," the Navajo Reservation is the largest reservation under Native American jurisdiction in the United States. The current population in the Navajo Nation surpasses 250,000 people. Upon the discovery of oil on Navajo land in the early 1920s, the modern system of tribal government was established to provide a formal government entity to interact with American oil companies. This tribal government was officially recognized by the federal government in 1923 (Navajo Nation 2008).

Pursuant to the Indian Reorganization Act of 1934 the only non-Indian mining rights or claims that may exist within the Navajo Reservation are valid rights or claims existing prior to the formation of the reservation (1880). The reservation itself is withdrawn from mineral entry. Even for private valid claims, however, the Navajo Nation is closed to uranium activity. On April 29, 2005, Navajo President Joe Shirley signed the Diné Natural Resources Protection Act of 2005, which was passed by the Navajo Nation Council on April 19, 2005. This law is based on the Fundamental Laws of the Diné, as codified in Navajo statutes, and clearly states, "No person shall engage in uranium mining and processing on any sites within Navajo Indian Country."

Havasupai Tribe

The Havasupai Reservation was established by the executive orders of June 8 and November 23, 1880, with an original size of 3,058 acres. By executive order in 1882, all but 518 acres at the bottom of the canyon were designated public land. However, on January 3, 1976, Public Law 93-620 returned the original acreage, added 185,019 acres surrounding the original lands and an additional 95,300 acres of traditional use area north of the reservation. Pursuant to the Indian Reorganization Act of 1934 the only non-Indian mining rights or claims that may exist within the Havasupai Reservation are valid rights or claims existing prior to the formation of the reservation (1880). The reservation itself is withdrawn from mineral entry. The 95,300 acres of additional traditional use lands are also withdrawn.

The Havasupai Reservation is situated in Coconino County at the southwest corner of Grand Canyon National Park. There are approximately 650 enrolled tribal members; approximately 340 members live in Supai Village—Havasupai tribal headquarters—in the 3,000 foot deep Havasu (Cataract) Canyon. The Tribe is governed by an elected seven-member Tribal Council (ADOC 2009d).

Kaibab Paiute Tribe

The Kaibab Paiute Indian Reservation was formally established by EO 1786 on October 16, 1907, which was superseded by EO 2667 on July 17, 1917. Pursuant to the Indian Reorganization Act of 1934 the only non-Indian mining rights or claims that may exist within the Kaibab Paiute Reservation are valid rights or claims existing prior to the formation of the reservation (1907). The reservation itself is withdrawn from mineral entry.

The reservation encompasses 120,413 acres in Arizona Strip country, including about 107,000 acres in Mohave County and about 13,000 acres in the southeastern part of the reservation in Coconino County. The reservation is composed of five villages: Kaibab, Steamboat, Juniper Estates, Six-Mile, and Redhills. The vast majority of the land is undeveloped. The Tribe is governed by a seven-person Tribal Council (ADOC 2008). Uranium has been found on or near the reservation (Bureau of Indian Affairs 1979).

3.1.7 Resource Condition Indicators

The resource condition indicators listed in Table 3.1-1 represent quantifiable measures of change that have been used to guide the impacts analysis presented in Chapter 4, Environmental Consequences. These indicators evolved through many iterations of impact analysis and are based on the original "relevant issues for detailed analysis" identified early in the EIS process through agency and public scoping (see Table 1.5-1).

Table 3.1-1. Resource Condition Indicators

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.2 Air Quality		
Quantity of criteria and hazardous air pollutants	The emissions from the emergency backup generator and the ore, waste rock unloading, and fugitive dust emissions from unpaved haul road travel associated with the Arizona 1 Mine are presented in Table 3.2-6. Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the life of the mine of ore production) and cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (Arizona Department of Environmental Quality [ADEQ] 2010a).	*Indicator*: Quantity of criteria and hazardous air pollutants emitted under each alternative.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.2 Air Quality, continued		
Regulatory requirements	Each individual mine will be required to obtain an air quality permit. The permit is the mechanism to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air.	*Indicator*: PSD: >250 tons per year (tpy) of a criteria pollutant. *Indicator*: Federal Hazardous Air Pollutant (HAP) Source: >25 tpy combined or >10 tpy of a regulated HAP. *Indicator*: ADEQ Class I Source: >100 tpy to <250 tpy of a criteria pollutant *Indicator*: ADEQ Class II Source: >2 tpy to <100 tpy of a criteria pollutant.
NAAQS	As shown in Table 3.2-5 and Figure 3.2-2, the ambient air concentration data obtained from monitors in or near the air quality study area were below the NAAQS. However, based on data obtained from the Grand Canyon National Park, the annual fourth-highest 8-hour ozone concentrations have flat trends nonetheless have values that are very close to 8-hour ozone standard (0.075 part per million [ppm]) and sometimes over it (NPS Public Use Statistics Office 2010).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern. The EPA recommends that this proposed "secondary" standard be in the range of 7 to 21 ppm-hours.	*Indicator*: Comparison of measured and/or modeled air pollutant concentrations with applicable thresholds (i.e., NAAQS).
Prevention of significant deterioration (PSD) increment	The PSD increments establish the maximum increase in pollutant concentration allowed above the baseline level.	*Indicator*: PSD is the mechanism that protect Class I areas.
GHGs	Qualitative and/or quantitative evaluations of potential contributing factors within the planning area will be included in Chapter 4 where appropriate and practicable.	*Indicator*: The quantity of GHG emission emitted under each alternative.
Air Quality Related Values – Visibility	The NPS has classified the visibility at the Grand Canyon National Park as a stable moderate concern. The standard visual ranges for the three Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors in Grand Canyon National Park range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days.	*Indicator*: Discussion of visibility impacts and comparison of measured or modeled values with applicable thresholds.
3.3 Geology and Mineral Resources		
Change in underground geological conditions	Mining of uranium deposits would alter conditions underground that could allow uranium and other minerals to be mobilized, entering the groundwater system. Conversely, mining of uranium deposits could remove a potential source of long-term contamination.	*Indicator*: Number of ore deposits mined. *Indicator*: Chemical quality of water discharge at springs that issue from perched groundwater zones. *Indicator*: Chemical quality of water discharge at springs that issue from the regional R-aquifer system. *Indicator*: Potential for subsidence and alteration of geology or topography.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.3 Geology and Mineral Resources, continued		
Availability of mineral resources	Providing a domestic source of mineral resources is one of the legitimate uses of public lands. Restrictions or closures individually and cumulatively decrease this ability.	*Indicator*: Uranium resource endowment available for development. *Indicator*: Cumulative amount of high-potential uranium resources on lands withdrawn from exploration and development. *Indicator*: Availability of high mineral potential lands within the withdrawal area *Indicator*: Amount of uranium mined as percentage of domestic demand, domestic production, global demand, and global production.
Depletion of uranium resources	Mining these uranium deposits in the near future depletes domestic resources that may be needed later for energy production or national security purposes.	*Indicator*: Amount of uranium mined as percent of known domestic resources. *Indicator*: Depletion of uranium resources within proposed withdrawal area.
3.4 Water Resources		
Dewatering or contamination of shallow perched aquifers	Mining of some uranium deposits would penetrate near-surface aquifers and could dewater them. The resulting water loss could affect nearby springs or shallow water wells. If mineral extraction occurs within the perched aquifer horizon, dissolved minerals could enter the perched aquifer where the perching layer is re-established by mine reclamation.	*Indicator*: The assumed number of perched aquifer springs and wells that might have water quantity or quality impacts as a result of mining related activities within the groundwater drainage area of the perched aquifers.
Contamination of deep regional aquifers by metals dissolved from mined ore deposits	Mine drainage might carry dissolved minerals downward and increase the levels of metals in the deep groundwater aquifers (e.g., Redwall-Muav limestone aquifer). This could occur both during mining and after mine closure and potentially affect downgradient water quality.	*Indicator*: The assumed number of active or reclaimed mines that might contribute impacted water to the deep aquifer, the assumed rate of mine drainage that might occur, and the assumed uranium and arsenic concentrations that might occur in the mine drainage. *Indicator*: The predicted concentrations of uranium and arsenic that might occur at deep aquifer springs if the assumed mine drainage would occur and mix with the deep aquifer spring flow.
Depletion of deep aquifer spring flow or well yields from operation of deep mine wells	Groundwater withdrawals from the deep aquifer by mine supply wells could intercept groundwater that supplies springs or could cause water level drawdown in deep non-mine wells.	*Indicator*: The predicted amount of groundwater pumping to supply uranium mining activities as a percent of flow from deep aquifer springs that might be impacted. Also, the predicted changes in groundwater level at deep non-mine wells that might be caused by mine wells.
Contamination or loss of the city of Tusayan water supply	The potential for the Tusayan city water supply to be affected by nearby uranium exploration or mineral exploration and development.	*Indicator*: The predicted changes in groundwater level and water quality at the deep city of Tusayan wells as a result of activities related to uranium mining.
Contamination of municipal water supplies derived from the Colorado River	The potential for elevated uranium and other metals, in either surface water or groundwater, to enter the Colorado River and affect the major downstream municipalities' primary source of drinking water.	*Indicator*: The assumed quality and quantity of water with elevated uranium and arsenic levels that might result from uranium mining activities and enter the Colorado River. *Indicator*: The predicted change in water quality to the Colorado River that might result from the above occurrences.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.4 Water Resources, continued		
Impairment of watershed and surface stream function	Changes in sediment loads and/or perennial and ephemeral stream discharge resulting from potential increased erosion and alteration of drainage patterns related to road, drill site, and mine site development.	*Indicator*: The amount of soil (area) that would be disturbed. *Indicator*: Estimated extent and degree of increased erosion (soil loss).
Contamination of surface runoff from active or reclaimed mines	Surface runoff from active or reclaimed mine sites could contain elevated uranium and other metals that would affect downstream water quality.	*Indicator*: Estimated uranium and arsenic levels in surface runoff.
3.5 Soil Resources		
Disturbance of soil resources	Soil resources in the area are valuable and could be difficult to re-establish once disturbed by exploration and mining.	*Indicator*: The amount of soil (area) that would be disturbed.
Loss of soil productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil productivity, creating potential short-term, long-term, and cumulative environmental impacts on soils and overall watershed function.	*Indicator*: The amount of soil (area) that would be disturbed. *Indicator*: Estimated extent and degree of increased erosion (soil loss).
Soil Contamination	Potential distribution of contaminants in soil could result from erosion and subsequent deposition of mine waste-rock or ore from water and/or wind action, or leakage from detention ponds in the vicinity of each mine site.	*Indicator*: Extent of projected concentrations of uranium and arsenic compared to background levels and Soil Remediation Level standards.
3.6 Vegetation Resources		
Disturbance of vegetation	Vegetation in the area are could be difficult to re-establish once disturbed or contaminated by exploration and mining.	*Indicator*: The amount of vegetation that would be disturbed and/or contaminated.
Vegetation productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil cover and vegetation productivity.	*Indicator*: The estimated loss in vegetation productivity (in Animal Unit Months). *Indicator*: The anticipated time required to return the disturbed or contaminated area to vegetative productivity.
3.7 Fish and Wildlife Resources		
Wildlife habitat	Issues associated with wildlife habitat include fragmentation of habitat by roads, noise from exploration or mining activities that disrupts wildlife, wildlife disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator*: Acres and type of habitat lost and duration of loss. *Indicator*: Changes in migratory or foraging behavior. *Indicator*: Avoidance or adaptation of species to noise source/visual intrusion. *Indicator*: Acres of habitat loss due to establishment of invasive species caused by mineral activities.
Wildlife populations	Potential loss of critical wildlife winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Wildlife mortality	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality. In addition to wildlife vehicle accidents, injury to individual plants from crushing or removal and loss or modification of habitat through actions such as clearing and road construction can have negative impacts on wildlife.	*Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.8 Special Status Species Resources		
Special status species habitat	Issues associated with special status species habitat include fragmentation of habitat by roads, noise from exploration or mining activities that disrupts species, species disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator*: Acres and type of habitat lost and duration of loss. *Indicator*: Changes in migratory or foraging behavior. *Indicator*: Avoidance or adaptation of species to noise source/visual intrusion. *Indicator*: Acres of habitat loss due to establishment of invasive species caused by mineral activities.
Special status species populations	Potential loss of critical special status species winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Special status species mortality	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality.	*Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity.
3.9 Visual Resources		
Changes in regional visual quality	Mineral exploration and development could release pollutants, which could increase regional haze (see Air Quality issue) and result in changes in visibility, affecting the scenic quality of the region.	*Indicator*: The extent of the predicted change in regional haze attributable to mineral exploration and development is noticeable.
Visual intrusion to Park visitors	Exploration and development activity may be visible to Park visitors from key viewpoints within the Park. This could detract from the visitors' experience.	*Indicator*: Consistency with and conformance to Park visual objectives from key viewpoints within Grand Canyon National Park. *Indicator*: Visual contrast of anticipated activity from these Park viewpoints.
Visual intrusion to public outside the Park	Exploration and development activity may be visible to the public from key viewpoints in the Proposed withdrawal area. This could detract from the visitors' experience.	*Indicator*: Consistency with and conformance to designated BLM Visual Resource Management class objectives *Indicator*: Consistency with and conformance to Forest Service scenic quality management or integrity objectives. *Indicator*: Visual contrast of anticipated activity from key viewpoints in the Proposed withdrawal area. *Indicator*: Qualitative analysis of the potential changes to darkness of the night sky in the Proposed withdrawal area and Grand Canyon National Park.
3.10 Soundscapes		
Noise disruption from exploration or development activity	The areas subject to noise effects and the intensity of sound from these activities need to be evaluated for each proposed site and all associated operations. Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park.	*Indicator*: The decibel level due to exploration and mining equipment *Indicator*: The distance and direction between the source and receiver and for the evaluation of noise attenuation to baseline sound levels. *Indicator*: Comparison measured or modeled values with applicable rules, policies, or orders established by the Federal Land Managers. *Indicator*: Comparison of specified values to regulations established by the EPA and the U.S. Department of Transportation.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.11 Cultural Resources		
Disturbance of historic and prehistoric sites	Surface disturbance associated with exploration or development activity could expose and cause damage to archaeological sites. Visual and atmospheric changes could adversely affect the integrity of site settings and what certain tribes assert to be cultural landscapes. It may not be possible to mitigate all adverse effects through scientific data recovery.	*Indicator*: The anticipated number of sites known, and unknown if possible, that could be disturbed by mining and exploratory activities. *Indicator*: The anticipated number of the above sites disturbed where information or artifacts would be lost or destroyed.
3.12 American Indian Resources		
Disturbance of traditional cultural practices and uses	Exploration and development activity could affect the integrity of religiously and culturally significant sites and landscapes and could disrupt traditional practices and uses. Such practices include ceremonial activities, gathering of plants or other natural resources, and use of springs and trails. Tribes have expressed concerns about potential disturbance and contamination of culturally important resources.	*Indicator*: Number and types of traditional cultural use areas, sacred sites, cultural landscapes, and trails that could be disturbed by mining and exploratory activities. *Indicator*: Number of acres of total possible disturbance by mining and exploratory activities. *Indicator*: Proximity of traditional use areas to anticipated exploration and development activity. *Indicator*: Types of auditory or visual disruptions would occur in the traditional use area.
Effect on TCPs	Surface disturbance associated with exploration or development activity could disrupt the setting or integrity of TCPs such as the Red Butte area on the Tusayan Ranger District or other TCPs located in or near the parcels.	*Indicator*: The proximity and size of possible surface, visual, or auditory disturbance to, or within, identified TCPs.
Protection of tribal trust resources or assets	Tribal trust resources and assets are property, or property rights or interests, actually owned by a tribe. These may include property or rights located on- or off-reservation. As a trustee for the tribes, the federal government has the responsibility to preserve and protect tribal trust resources and assets from loss or degradation. One trust resource issue is the potential contamination of Havasu Springs and the economic impact of reduced tourism for the Havasupai Tribe if the springs were to be contaminated.	*Indicator*: Location and nature of tribal trust resource or asset. *Indicator*: Manner and degree to which the resource or asset would be degraded or consumed.
3.13 Wilderness Resources		
Wilderness areas	Congressionally designated wilderness is already withdrawn from entry and location under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to designated wilderness areas, which may affect the wilderness characteristics.	*Indicator*: Changes in wilderness characteristics untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.
3.15 Recreation		
Access and transportation	Development of roads for mining operations could both facilitate access for some recreational users and provide too much public access in areas currently used for more primitive recreation.	*Indicator*: Road density in terms of linear road miles by road type and designated recreation area and visitor use.
Primitive recreation opportunities	Changes in amount of exploration and development activity could change visual and auditory conditions, which in turn could affect primitive recreation opportunities in the area.	*Indicator*: The proximity of recreation settings and opportunities suitable for primitive recreational use to RFD and the expected auditory and visual intrusion to the desired recreation experience.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.16 Social Conditions		
Demographics	There could be changes in population levels associated with decreased exploration and development activity under a proposed withdrawal. Likewise, the continued mineral development in the absence of a proposed withdrawal could involve local population increases as additional workers are required.	*Indicator*: The current and projected population for counties and communities in the study area.
Stakeholder values	Stakeholder values may be affected by changes in land management related to the proposed withdrawal areas.	*Indicator*: Public comments during scoping indicating general support for the withdrawal or support for exploration and development activity (and no withdrawal).
Public health effects	The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport.	*Indicator*: Estimated number of haul trips through local communities. *Indicator*: Potential exposure, public health risk, from single incident, effectiveness of cleanup, and total anticipated incidents.
Environmental justice	The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. In the 1994 EO (12898), President Clinton adopted the phrase “environmental justice” to refer to “disproportionately high and adverse human health or environmental effects . . . on minority populations and low-income populations.” Environmental justice is the equitable distribution of proposed withdrawal benefits and risks with respect to low-income or minority populations. In the case of uranium mining in the proposed withdrawal area, it is the distribution of the proposed withdrawal benefits, primarily economic, compared with the distribution of the proposed withdrawal impacts, such as pollution or risk of pollution, that is the issue.	*Indicator*: Identification of populations considered low income and/or minority in the proposed withdrawal area that would either be adversely affected or benefit from the activity. *Indicator*: Distribution of proposed withdrawal risks or adverse effects on the above populations.
3.17 Economic Resources		
Energy resources available	The withdrawal of uranium deposits in the study area would remove a potential source of energy production, which would then be replaced by energy produced from other sources, either additional mining elsewhere, imports of uranium from foreign sources, or production from equivalent amounts of other sources like coal, petroleum, natural gas, wind power, or solar.	*Indicator:* Value of energy produced from study area. *Indicator:* Equivalent amount of other energy-producing commodity represented by uranium production.
Effects on economic activity from tourism	Tourism represents a large component of the economic activity for many communities in the region and for the states. The manner and degree to which continued mining could change the nature and quality of the natural resources that attract tourism is an issue.	*Indicator*: Visitor user days and value per visitor user days to tourist destinations, primarily Grand Canyon National Park, but also National Forest System and BLM lands.
Effects on economic activity from mineral development	Mineral exploration and development represents a large component of the economic activity for many communities in the region. The manner and degree to which the proposed withdrawal could directly change the economic activity in the area, particularly in smaller communities, is an issue.	*Indicator*: Number of persons in the region directly and indirectly employed by the uranium mining industry. *Indicator*: Local and state revenue from property and income taxes directly tied to uranium mineral exploration and development.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.17 Economic Resources, continued		
Road condition and maintenance	The use of road systems to service mine operations requires increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access. Increased exploration and development activity could presumably increase funding from property and use taxes at the same time at which maintenance needs increase. Conversely, decreases in activity mean less maintenance, along with less potential revenue.	*Indicator*: Number of haul trips anticipated on major public use roads over the next 20 years. *Indicator*: Required maintenance level on public roads systems used for mineral operations. *Indicator*: The net change in funding available for road maintenance.

3.2 AIR QUALITY

This section provides an assessment of ambient air quality in the proposed withdrawal study area (Figure 3.2-1). The air quality of a given airshed or region is determined by the topography, meteorology, location of sources of air pollutants (type and quantity), and combination of air pollutants. The calculated or measured concentrations of various pollutants are then compared with established standards to evaluate the impact of a given source on regional air quality.

The purpose of this assessment is to determine the ambient air quality within the proposed withdrawal area. For the purposes of evaluating air quality resource impacts associated with the proposed withdrawal, the geographic extent of the air quality study area was assumed to extend 31 miles (50 km) from the boundaries of the proposed withdrawal area. A 31-mile radius was chosen in order to be consistent with minimum air quality analysis required for major source air quality permitting. Specifically, when conducting an air quality impact analysis for a major emission source, the analysis considers the geographical area located within at least a 31-mile radius. The region of influence is the total area in which measurable impacts of the proposed action are evaluated and may extend well beyond 31 miles from the proposed withdrawal boundaries.

3.2.1 Climate and Meteorology

The three proposed withdrawal parcels are located in northwestern Arizona within the Colorado Plateau, which is characterized by highlands to the north and lowlands to the south and west. The Colorado Plateau contains many unique geographical features (e.g., river narrows, natural bridges, slot canyons, etc.), including Grand Canyon. Six of the seven North American life zones are represented within the Colorado Plateau; only sub-tropic is absent. The Colorado Plateau contains a variety of plant life, from desert-type vegetation in the low-lying rocky areas to forests of ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*) and aspen (*Populus* sp.) in the higher elevations (BLM 1999).

The proposed withdrawal parcels are managed by the BLM Arizona Strip District and the Forest Service Kaibab National Forest–Tusayan Ranger District. The North and East parcels are almost entirely BLM lands, located north of the Colorado River, with small portions of the Kaibab National Forest in each. The South Parcel is entirely National Forest System lands (Kaibab National Forest–Tusayan Ranger District) located south of the Colorado River. All three of the proposed withdrawal parcels border the Grand Canyon National Park, managed by the NPS.

The northwestern portion of Arizona has four defined seasons (e.g., summer, fall, winter, and spring) and is at significantly higher elevation than the lower desert regions in southern Arizona, with an appreciably cooler climate that consists of cold winters and relatively mild summers. Air temperatures vary considerably both diurnally and annually throughout the area and can vary greatly depending on elevation, as evidenced by the monitoring data. During summer, the average air temperature in degrees Fahrenheit (°F) ranges from the mid-40s to the mid-70s, with highs reaching the low 100s. In comparison, the average minimum temperature in winter generally ranges from the mid- to high 10s to the high 30s, with the average maximum temperature reaching the high 50s and low 60s. Cold air systems originating from the northern United States and Canada occasionally make their way into Arizona, bringing temperatures below 0°F to the northern portions of the state. There are several climatic elements that have an impact on air quality. These elements include winds, temperature, and precipitation. Table 3.2-1 summarizes the meteorological conditions in and near the proposed withdrawal area.

Precipitation amounts tend to be highest in the winter months, ranging from approximately 0.5 inch (Houserock, Arizona) to 3.17 inches (Bright Angel Ranger Station, Arizona), and lowest in the spring months, ranging from 0.3 inch (Houserock) to 1.91 inches (Bright Angel Ranger Station). Not all of the meteorological monitoring stations record snowfall during the winter months; the annual average accumulation ranges from 0.3 inch (Phantom Ranch, Arizona) to 136.7 inches (Bright Angel Ranger Station, Arizona).

Table 3.2-1. Meteorological Conditions in and near the Proposed Withdrawal Air Quality Study Area

Monitor Locations (Arizona)	Approximate Distance and Direction from the Nearest Proposed Withdrawal Parcel	Winter Average	Spring Average	Summer Average	Fall Average	Annual Average/ Total
Mean Monthly Maximum Temperature Average (°F)*						
Bright Angel Ranger Station	10 miles N	39.1	53.0	75.1	57.7	**56.2**
Gunsight	(In withdrawal area)	62.0	82.4	100.3	83.3	**82.0**
Houserock	(In withdrawal area)	61.5	82.3	99.3	81.8	**81.2**
Paria Point	(In withdrawal area)	56.0	76.1	93.7	76.7	**75.6**
Phantom Ranch	7 miles N	59.0	82.1	103.7	82.1	**81.8**
Pipe Springs National Monument	3 miles N	50.0	69.5	92.0	72.1	**70.9**
Robinson Tank	(in withdrawal area)	62.6	81.6	99.8	83.6	**81.9**
Supai	18 miles NW	55.1	76.3	96.8	76.6	**76.2**
Telegraph Flat–Kanab 17E Utah	18 miles N	57.2	79.6	98.1	80.3	**78.8**
Tuweep	18 miles S	51.6	68.9	91.8	73.2	**71.4**
Mean Monthly Minimum Temperature Average (°F)*						
Bright Angel Ranger Station	10 miles N	17.5	27.6	44.3	31.3	**30.2**
Gunsight	(In withdrawal area)	14.7	27.8	52.4	30.4	**31.3**
Houserock	(In withdrawal area)	19.0	31.2	55.3	34.3	**35.0**
Paria Point	(In withdrawal area)	10.9	23.7	49.2	26.2	**27.5**
Phantom Ranch	7 miles N	38.7	55.0	74.3	57.2	**56.3**
Pipe Springs National Monument	3 miles N	23.1	35.9	55.8	39.1	**38.5**
Robinson Tank	(In withdrawal area)	5.7	21.3	44.0	23.1	**23.5**
Supai	18 miles NW	31.3	46.0	64.7	47.9	**47.5**
Telegraph Flat–Kanab 17E Utah	18 miles N	6.6	21.1	42.1	24.8	**23.7**
Tuweep	18 miles S	28.9	40.8	61.8	45.7	**44.3**

Table 3.2-1. Meteorological Conditions in and near the Proposed Withdrawal Air Quality Study Area (Continued)

Monitor Locations (Arizona)	Approximate Distance and Direction from the Nearest Proposed Withdrawal Parcel	Winter Average	Spring Average	Summer Average	Fall Average	Annual Average/ Total
Mean Monthly Precipitation Average (inches)*						
Bright Angel Ranger Station	10 miles N	3.17	1.91	1.66	1.65	**25.19**
Gunsight	(In withdrawal area)	0.8	0.5	0.7	0.8	**8.4**
Houserock	(In withdrawal area)	0.5	0.3	0.8	0.9	**7.4**
Paria Point	(In withdrawal area)	0.7	0.7	0.9	0.9	**9.8**
Phantom Ranch	7 miles N	0.89	0.59	0.82	0.90	**9.61**
Pipe Springs National Monument	3 miles N	1.06	0.80	0.88	0.91	**10.94**
Robinson Tank	(In withdrawal area)	0.9	0.4	0.6	0.5	**6.9**
Supai	18 miles NW	0.73	0.54	0.95	0.64	**8.59**
Telegraph Flat–Kanab 17E Utah	18 miles N	0.8	0.5	0.6	0.9	**8.1**
Tuweep	18 miles S	1.11	0.79	1.20	0.88	**11.95**
Mean Monthly Snowfall Average (inches)*						
Bright Angel Ranger Station	10 miles N	26.6	13.4	0.1	5.5	**136.7**
Gunsight	(In withdrawal area)	–	–	–	–	–
Houserock	(In withdrawal area)	–	–	–	–	–
Paria Point	(In withdrawal area)	–	–	–	–	–
Phantom Ranch	7 miles N	0.2	0.0	0.0	0.0	**0.3**
Pipe Springs National Monument	3 miles N	1.9	0.6	0.0	0.4	**8.6**
Robinson Tank	(In withdrawal area)	–	–	–	–	–
Supai	18 miles NW	0.5	0.0	0.0	0.0	**1.7**
Telegraph Flat–Kanab 17E Utah	18 miles N	–	–	–	–	–
Tuweep	18 miles S	2.0	0.6	0.0	0.2	**8.5**
Average Wind Speed (miles per hour)†						
Flagstaff Airport	42 miles S	6.6	8.0	5.9	5.8	**6.6**
Grand Canyon Airport	(In withdrawal area)	6.2	7.6	6.1	5.8	**6.4**
Kanab Airport	10 miles N	6.7	9.5	7.7	6.6	**7.6**
Page Airport	13 miles NE	3.5	6.4	6.0	4.3	**5.0**

Sources: Western Regional Climate Center (2010a, 2010b).

Note: – = No data available; N = North; NE = Northeast; NW = Northwest; S = South; SW = Southwest

* For mean monthly temperature, mean monthly precipitation, and mean monthly snowfall, the period used for Bright Angel Ranger Station is 1925–2009; for Gunsight, 1994–2010; for Houserock, 1994–2010; for Paria Point, 1994–2010; for Phantom Ranch, AZ 1966-2005; for Pipe Springs National Monument 1993-2005; for Robinson Tank, 1986–2010; for Supai, 1899–1987; for Telegraph Flat–Kanab 17E, Utah, 1987–2010, and for Tuweep, 1941–1985.

† For average wind speed values, averages are based on data collected between 1996 and 2006.

Based on Table 3.2-1, average wind speeds tend to be highest during the spring and summer months, ranging from approximately 6.0 miles per hour (mph) (Page Airport, Arizona) to 9.5 mph (Kanab Airport, Utah) and lowest during the winter and fall months, ranging from approximately 3.5 mph (Page Airport, Arizona) to 6.7 mph (Kanab Airport, Utah).

The closest meteorological monitoring station to the proposed withdrawal area is the station located at Grand Canyon Airport, Arizona, within the South Parcel. Wind data collected at the Grand Canyon

Airport indicate the prevailing winds are generally from the south-southwest, with significant winds from the northeast in winter with the average annual wind speed approximately 6.4 mph. The daily average peak gust at the Grand Canyon Airport are 25.4 mph with maximum peaks exceeding 60 mph (peak gust of 62 mph recorded on December 13, 2008) (Western Regional Climate Center 2010b).

Wind events near the proposed withdrawal can be extreme, as evidenced by the closure of Interstate 40 (I-40), east of Flagstaff, on numerous occasions in 2010 as a result of blowing dust from sustained winds exceeding 50 mph. As of June 16, 2010, the maximum recorded wind gust at the Flagstaff Airport for the calendar year 2010 was measured at 55 mph. From 2009 through 2006, the maximum gust wind measured, at the Flagstaff Airport, ranged from 56 to 59 mph (Weather Underground 2010).

In the absence of strong prevailing winds, wind movement within the valleys, canyons, and gulches within northern Arizona is extremely complex. The terrain features suggest there is a daily exchange of downslope and upslope flows oriented along the terrain feature axes, which are controlled by surface heating and cooling. Downslope, or drainage flows, which last longer, occur during the evening, night, and early morning hours, while the upslope flows occur during midday, the warmest part of the day (Bowman 2010).

Atmospheric stability is another important factor of meteorology that determines air pollution concentrations. When the atmosphere is stable, emitted pollutants tend to remain within a few hundred feet of the surface (close to the emission sources), and begin to diffuse horizontally across the surface. When the atmosphere is unstable, air pollution is free to mix with the atmosphere, and can vertically rise 1,000 feet or more, and be carried away in the prevailing wind. Therefore, the depth of this “mixing” area is very important when considering the impacts of air pollution on the region of influence.

Within the proposed withdrawal area atmospheric stability depends on the season. During the summer, the frequency of stable and unstable conditions of the atmosphere is relatively equal.

3.2.2 Legal and Regulatory Requirements

The following subsections identify federal, state, and local laws and regulations that are applicable to the proposed withdrawal, provide an evaluation of the study area, and analysis of the potential proposed withdrawal impacts.

Federal Laws and Regulations

Since 1970, the CAA and subsequent amendments have provided the authority and framework for EPA regulations of ambient air and pollutant emission sources. The CAA is the primary federal legislation controlling air quality standards and also includes special provisions to help protect air quality in national parks and other federal lands. The CAA gives federal land managers certain responsibilities and opportunities to participate in decisions being made by regulatory agencies that might affect air quality in federally protected areas.

The EPA regulations promulgated pursuant to the authority provided under the CAA established requirements for monitoring, controlling, and documenting activities that would affect ambient air concentrations of certain pollutants that may endanger public health or welfare. Specifically, these regulations have the overall objective of achieving and maintaining adherence to appropriate standards for ambient air quality, which are referred to as NAAQS.

National Ambient Air Quality Standards

As stated above, the CAA established the NAAQS for six criteria pollutants. These pollutants are carbon monoxide (CO), lead (or Pb), nitrogen dioxide (NO_2), particulate matter with a nominal aerodynamic diameter of less than 10 micrometers (PM_{10}) and fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers ($PM_{2.5}$), ozone (or O_3), and sulfur dioxide (SO_2). These standards are defined in terms of threshold concentration (e.g., milligrams per cubic meter [mg/m^3], micrograms per cubic meter [$\mu g/m^3$], or parts per million [ppm]) measured as an average for specified periods (averaging times). Short-term standards (i.e., 1-hour, 8-hour, or 24-hour averaging times) were established for pollutants with acute health effects; long-term standards (i.e., annual averaging times) were established for pollutants with chronic health effects.

The NAAQS were set at levels to provide an ample margin of safety to protect both public health and the environment. The primary standards are "health effects" standards and were adopted to protect public health, including "sensitive" populations such as asthmatics, children, and the elderly. The secondary standards are "quality of life standards" and were adopted to protect public welfare against decreased visibility as well as damage to animals, crops, vegetation, and buildings. The secondary standards are the same as, or less stringent than, the primary standards.

Effective May 27, 2008, the EPA promulgated a new 8-hour average O_3 concentration of 0.075 ppm. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentration measured at each monitoring location within an area over each year must not exceed 0.075 ppm. The primary and secondary NAAQS for the criteria pollutants are presented in Table 3.2-2.

Table 3.2-2. National Ambient Air Quality Standards

Pollutant	Averaging Period	Primary Standard	Secondary Standard
CO	1-hour	35 ppm (40 mg/m^3)	–
	8-hour	9 ppm (10 mg/m^3)	–
Pb	Rolling 3-Month Average	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$
	Quarterly Average	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$
NO_2	1-hour	0.100 ppm	0.100 ppm
	Annual	0.053 ppm (100 $\mu g/m^3$)	0.053 ppm (100 $\mu g/m^3$)
PM_{10}	24-hour	150 $\mu g/m^3$	150 $\mu g/m^3$
$PM_{2.5}$	24-hour	35 $\mu g/m^3$	35 $\mu g/m^3$
	Annual	15.0 $\mu g/m^3$	15.0 $\mu g/m^3$
O_3	1-hour	0.12 ppm	0.12 ppm
	8-hour	0.08 ppm (1997 standard)	0.08 ppm (1997 standard)
	8-hour	0.075 ppm (2008 standard)	0.075 ppm (2008 standard)
SO_2	3-hour	–	0.5 ppm (1,300 $\mu g/m^3$)
	24-hour	0.14 ppm	–
	Annual	0.03 ppm	–

Sources: EPA (2010a–i).

Note: – = No data available; ppm = parts per million; $\mu g/m^3$ = micrograms per cubic meter

Geographic areas commonly referred to as airsheds, which may not coincide with political boundaries, are designated attainment, non-attainment, or unclassified areas for each of the six criteria pollutants covered by the NAAQS. Areas in which levels of a criteria pollutant measure below the NAAQS are designated "attainment" areas. However, when a designated air quality area or airshed within a state exceeds the

NAAQS that area may be designated a "non-attainment" area. Typically, non-attainment areas are urban regions and/or areas with higher-density industrial development. The given status of an area is designated separately for each criteria pollutant; one area may have all three classifications.

To determine whether an area meets the NAAQS, air monitoring networks have been established and are used to measure ambient air quality concentrations. Monitoring sites are typically located in areas where high concentrations occur within a region and where an exceedance is expected to occur.

Air pollution emitted in one area (e.g., North Parcel) is not bound by the parcel boundaries and could spread out and become distributed across the airshed. Air pollutants have the potential to disperse over large geographic areas. For this reason, air pollution levels are generally similar across a given airshed. The boundaries of an airshed can be difficult to determine due to changing meteorological conditions. Topographical features such as, ridges and mountains may prevent the circulation of air and hold pollution within their boundaries. However, weather conditions can change on a daily basis, and features that obstruct the movement of air on some days may represent no barrier at all when a weather front pushes through.

The proposed withdrawal parcels are located in Coconino and Mohave counties, which are designated as being in attainment for all criteria pollutants as defined under the EPA NAAQS.

An unclassified designation indicates that the status of attainment has not been verified through data collection. When permitting new sources, an unclassified area is treated as an attainment area (ADEQ 2010b).

Class I and Class II Areas

Clean air designations were established under the CAA Title I, Part C, Prevention of Significant Deterioration (PSD) of Air Quality. Specific provisions are included in federal, state, and county air quality regulations to preserve the pristine air quality in Class I areas.

Designation as a Class I area allows only very small increments of new pollution above already existing air pollution levels. Generally, the Class I air quality/land use classification is the designation for clean, pristine airsheds and would permit little or no development and signifies a goal, which is implemented by requiring the most stringent controls on air pollutant sources. The Class II designation is applied to all other clean air areas that are in attainment of the NAAQS, where development is permitted under the authority of the state. Class I areas include national parks larger than 6,000 acres, and wilderness areas larger than 5,000 acres that were in existence before August 1977.

However, certain areas deserving of preservation, established by the Wilderness Act of 1964, may be designated Class II "Wilderness," and state or county requirements or permitting policies may be promulgated to protect air quality in these areas. Except for fires and wind erosion, the potential for adverse air quality impacts is from human-caused pollutants transported into these areas by gradient and/or local winds. Class II areas include all other areas of the country that are not Class I.

The proposed withdrawal parcels are designated as Class II for criteria pollutants. One federally designated Class I area, the Grand Canyon National Park, borders the proposed withdrawal parcels (see Figure 3.2-1). There are several other Class I and II areas in close proximity to the proposed withdrawal parcels, including Zion (approximately 21 miles to the north) and Bryce Canyon (approximately 30 miles to the north) national parks, located in Utah (all Class I); Glen Canyon and Lake Mead national recreation areas; Grand Canyon–Parashant, Pipe Springs, Wupatki, Grand Staircase–Escalante, Vermilion Cliffs, and Sunset Crater Volcano national monuments; and Paria Canyon–Vermilion Cliffs and Kanab Creek wilderness (Class II). Other wilderness areas not identified on Figure 3.2-1 include Cottonwood Point, Saddle Mountain, Mount Trumbull, and Mount Logan.

Prevention of Significant Deterioration

In addition to the NAAQS discussed above, the EPA promulgated PSD regulations to further protect and enhance air quality. PSD review is a pollutant-specific review and a federally mandated program. This PSD review applies to new emission sources in areas designated attainment or unclassified, and it applies only to pollutants for which a project is considered a potential major contributor. The PSD provisions use an incremental approach and are intended to help maintain good air quality in areas that attain the NAAQS and to provide special protections for areas of special natural recreational, scenic, or historic value, such as national parks and wildlife areas.

PSD permits are required for major new stationary sources of emissions that emit 250 tons (100 tons for categorical sources) or more per year of an air pollutant. Uranium mining is not listed as one of the 28 designated categories. Therefore, the applicable PSD threshold is 250 tons per year. The main requirements of the PSD review process are to demonstrate that projects would do the following:

- Incorporate best available control technology (BACT);
- Evaluate existing ambient air quality in the area of the project;
- Demonstrate that the project would not cause or significantly contribute to a violation of the NAAQS or PSD increments;
- Determine the impacts on soils, vegetations, and visibility for Class I areas;
- Evaluate the air quality impacts resulting from indirect growth associated with the project; and
- Provide for public involvement.

The PSD regulations at the federal and state levels define numerical values for "increments" that are maximum allowable increases in predicted ambient concentrations at any location. The regulations also define the predicted concentrations that trigger an ambient monitoring requirement for a given project.

"Increments" are maximum increases in ambient concentrations allowed in an area above the baseline concentration. Class I increments have been established for PM_{10}, SO_2, and NO_2 and are listed in Table 3.2-2. These represent the maximum increases in ambient pollutant concentrations allowed over baseline concentrations. Complete consumption of an increment would impose a restriction to growth for the affected area. It does not necessarily indicate an adverse health impact.

The "significant impact levels" (SILs) and "monitoring de minimis concentrations" are numerical values that represent thresholds of insignificance (i.e., de minimis, modeled source impacts or monitored ambient concentrations, respectively). The SIL and monitoring de minimis concentration thresholds are used as screening tools by a major source subject to PSD to determine the level of analysis and data gathering required for a PSD permit application.

PSD regulations state that, in the event the screening-level analysis yields ground-level concentrations that exceed a defined SIL concentration, then a refined air quality analysis must be completed. If the significance analysis modeled impacts are greater than the de minimis levels, a refined analysis would be performed based on at least one year of on-site meteorological data and site-specific topography. In this analysis, existing and permitted sources of pollutants within the region of influence must be considered to evaluate the PSD Class I and Class II increments consumed by the project in conjunction with the background pollutant sources. If modeling shows an increase in ambient concentrations of air pollution by an amount less than the de minimis levels the source is exempted from the site-specific ambient monitoring data requirement.

If and when the regulatory authority reaches a preliminary decision to authorize construction of each proposed major new source, it must provide notice of the preliminary decision and an opportunity for the general public, industry, and others that may be affected by the emissions of the major source to comment before issuing a final decision.

In the context of PSD permitting requirements, a PSD increment evaluation and NAAQS evaluation are conducted to assess potential cumulative impacts on air quality. The PSD increment analysis is used to estimate the degradation of air quality caused by construction of manmade sources of air pollution after certain baseline dates. For PSD baseline purposes, a baseline date is the submittal date of the first completed PSD permit application in a particular area. The NAAQS evaluation, which includes background pollutant concentrations, is used to estimate the total impacts of all natural and manmade sources of air pollution on air quality, compared with the pollutant concentrations at which human health or the environment could be impacted.

The maximum allowable PSD increments over baseline, SILs, and monitoring de minimis concentrations are summarized in Table 3.2-3.

Table 3.2-3. PSD of Air Quality Increments, Significant Impact Levels, and Monitoring de Minimis Concentrations

Pollutant	Averaging Time	PSD Increments Class I (μg/m^3)	PSD Increments Class II (μg/m^3)	SILs Class I (μg/m^3)	SILs Class II (μg/m^3)	Monitoring de Minimis Concentrations (μg/m^3)
PM_{10}	Annual	4	17	0.16	1	N/A
	24-hour	8	30	0.32	5	10
SO_2	Annual	2	20	0.08	1	N/A
	24-hour	5	91	0.2	5	13
	3-hour	25	512	1	25	N/A
NO_2	Annual	2.5	25	0.1	1	14
CO	8-hour	N/A	N/A	N/A	500	575
	1-hour	N/A	N/A	N/A	2,000	N/A

Source: 40 CFR 52.21.

Note: N/A = Not applicable; μg/m^3 = micrograms per cubic meter

Air Quality Related Values

In cases where a proposed project's emissions may adversely affect an area classified as a Class I area, additional review is conducted to protect the increments and special attributes of such an area defined as air quality related values (AQRVs). These AQRVs are scenic, cultural, physical, biological, ecological, or recreational resources that may be affected by a change in air quality as defined by the federal land manager for federal lands. AQRVs are applicable in NPS (Grand Canyon National Park), USFWS, Forest Service, and BLM Class I areas. The specific AQRVs of concern are dependent on a number of variables, including the evolving state of the science, project-specific pollutants, site-specific management concerns, and the existing condition of the AQRVs. Please refer to Section 3.2.3, Existing Air Quality, for a discussion of the specific AQRV, visibility.

In general, the assessment of these impacts is based on dispersion modeling covering both short-range and long-range transport of PM_{10}, SO_2, and NO_2. The AQRV analysis required for PSD permitting of new major sources includes consideration of potential impacts on visibility, acid rain, sensitive species, soils, flora, and fauna that are associated with air emissions of a proposed project.

New Source Performance Standards

The New Source Performance Standards promulgated by EPA pursuant to Section 111 of the CAA establish emission limitations, work-practice standards, and provisions for monitoring, recordkeeping, and reporting applicable to new stationary sources of criteria pollutants. The New Source Performance Standards are codified at 40 CFR 60. At first, 40 CFR 60, Subpart LL, Standards of Performance for Metallic Mineral Processing Plants, appeared to be applicable; however, upon further review, Subpart LL provided certain exemptions for facilities located in underground mines and uranium ore processing plants, including all facilities subsequent to and including beneficiation of uranium ore. Therefore, no New Source Performance Standards are applicable to uranium mining.

National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants include emission limitations, work-practice standards, and provisions for monitoring, recordkeeping, and reporting of hazardous air pollutants not covered by the NAAQS. These standards were promulgated pursuant to Section 112 of the CAA and are codified at 40 CFR Parts 61 and 63. The Part 63 standards apply to specific source categories and require affected facilities to implement maximum achievable control technology for specific hazardous air pollutants specified in each subpart.

Radon is a radioactive gas formed as part of the radioactive decay chain of uranium and is considered a hazardous air pollutant. Several subparts under Part 61 appear to potentially apply to uranium mining and processing activities. Those potentially applicable subparts are as follows:

- 40 CFR Part 61 Subpart B, National Emission Standards for Radon Emissions from Underground Uranium Mines;
- 40 CFR Part 61 Subpart T, National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings; and
- 40 CFR Part 61 Subpart W, National Emission Standards for Radon Emissions from Operating Mill Tailings.

Radon-222 emissions from the underground uranium mining activities are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the life of the mine of ore production) cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem. The applicability of 40 CFR Part 61 Subpart B defines which individual processes are subject to the emission limitations established in the regulation. A mine whose production is less than 10,000 tons of ore per year or 100,000 tons of ore over its lifetime is not subject to 40 CFR Part 61 Subpart B.

It should be noted that all mined uranium ore is transported to and processed at the White Mesa Mill, located in Blanding, Utah. No uranium ore processing would occur within the proposed withdrawal area.

Department of Transportation

The transportation of uranium ore is regulated under 49 CFR Subchapter C – *Hazardous Materials Regulations*. Several parts under Subchapter C appear to potentially apply to transport of uranium ore from the mine location to the processing facility. These regulations were promulgated by the U.S. Department of Transportation, and potentially applicable parts are as follows:

- Part 171 – *General Information, Regulations, and Definitions*;

- Part 172 – *Hazardous Materials Table, Special Provisions, Hazard Materials Communications, Emergency Response Information, Training Requirements, and Security Plans*; and
- Part 177 – *Carriage by Public Highway*.

Compliance with these regulations would be the requirement of any affected mining operation for the transport of uranium ore from the mine location to the processing facility.

Clean Air Act Title V Permit Program

Under the federal operating permit program established by Title V of the 1990 CAA Amendments, federal, state, and local agencies delegated the authority to administer and enforce the program shall issue air quality operating permits to major stationary sources of air pollutant emissions. Under Title V, major sources are those with a potential to emit: 100 tons per year or more of any one regulated pollutant (PM_{10}; NO_x, SO_2, CO, volatile organic compounds [VOCs], and Pb), 10 tpy or more of any one hazardous air pollutant (HAPs), or 25 tpy or more of any two or more HAPs.

The implementing EPA regulations are codified at 40 CFR 70 and 71. Title V permits identify all applicable requirements under the act, create a “permit shield,” and establish requirements for monitoring, recordkeeping, reporting, and annual compliance certifications. ADEQ was delegated the authority to administer the federal Title V permit program in all areas of Arizona except Maricopa, Pinal, and Pima counties and all areas within the borders of an Indian reservation. Therefore, any “major” uranium mining facilities would be required to submit a Title V air permit application to the ADEQ.

Under Title V of the CAA some tribal lands have been delegated authority to regulate air quality. In the area of northern Arizona and southern Utah, the Navajo Nation is the only tribal government granted this authority. Other tribal nations in the withdrawal area can participate in permitting activities but have not been granted the authority to regulate air quality.

Title 49, Transportation of Hazardous Materials

Transportation of uranium ore is regulated by Title 49 Parts 171, 172, 173, and 177, which classifies and determines specific transportation requirements for hazardous materials. Uranium ore is classified as a Class 7 radioactive material, and Title 49 Part 173.403 classifies uranium or as a Low Specific Activity (LSA) Group 1 material. The LSA-1 designation of ore shipments general exempts them from most of the labeling and placarding requirements of other Class 7 radioactive materials. Title 49 regulations control loading, shipping, packaging, reporting, and emergency procedures.

State Laws and Regulations

ADEQ has been delegated the authority to administer and enforce the CAA, federal, and state regulations and standards in Coconino and Mohave counties, Arizona (location of the proposed withdrawal parcels); with the exception of those regulations at 40 CFR Part 61 Subpart B. Those regulations are administered by Region 9 of the EPA. The uranium processing site is located in Blanding, San Juan County, Utah. The Utah Department of Environmental Quality (UDEQ) enforces air quality regulations in that area (UDEQ 2010).

ARIZONA LAWS AND REGULATIONS

The proposed withdrawal parcels are located in Coconino and Mohave counties, Arizona. ADEQ air quality regulations are provided in Title 18, Chapter 2 of the Arizona Administrative Code (AAC). These regulations establish ambient air quality standards for the state that are equivalent to the NAAQS. The

AAC also includes promulgated emission limits and workplace standards for specific categorical sources that might be applicable to certain activities within the air quality study areas.

The EPA has delegated ADEQ the authority under the CAA to regulate air quality and issue air quality permits. This permitting process is the primary way that ADEQ balances environmental protection and economic development. The ADEQ Air Quality Division issues air quality permits to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air. Moreover, the permitting process allows citizens to stay informed and involved as these proposed air quality permitting decisions are made.

ADEQ receives the authority to require air modeling for new major sources and major modifications to existing sources from the AAC R18-2-407. Furthermore, the Arizona Revised Statutes (ARS) §49-422, describes the broad authority of the ADEQ Director in regards to the quantification of the air contaminants. This authority allows the Director to require a source of contaminants, by permit or executive order, to quantify its emissions of air pollution. Therefore, on a case-by-case basis, ADEQ also requires that permit applicants perform modeling analyses for both minor sources and minor modifications.

Global Climate Change

Climate change is a global problem that results from global GHG emissions. There are more sources and actions emitting GHGs (in terms of both absolute numbers and types) than are typically encountered when evaluating the emissions of other pollutants. These emissions are often categorized as either anthropogenic (human-caused) or non-anthropogenic (naturally occurring). From a quantitative perspective, there is no single dominating anthropogenic source and fewer sources that would even be close to dominating total GHG emissions. The global climate change problem is much more the result of numerous and varied sources, each of which might seem to make a relatively small addition to global atmospheric GHG concentrations. Currently, there are no sites within the study area that are collecting ambient GHG data. Ambient background data that exist are parametrically derived from fossil fuel combustion and other industrial sources.

Projected climate change impacts include air temperature increases; sea level rise; changes in the timing, location, and quantity of precipitation; and increased frequency of extreme weather events such as heat waves, droughts, and floods. These changes will vary regionally and affect renewable resources, aquatic and terrestrial ecosystems, and agriculture. While uncertainties will remain regarding the timing and extent magnitude of climate change impacts, the scientific evidence predicts that continued increases in GHG emissions will lead to increased climate change.

The proposed alternatives would be a source of carbon dioxide (CO_2) and other GHGs, which could have an undetermined effect on local, regional, and global climate change. This analysis is unable to identify the specific impacts of the proposed alternatives GHG on global warming and climate change because there is insufficient information and numerous models, which produce widely divergent results.

Therefore, it is difficult to state with any certainty what impacts on global warming may result from GHG emissions, or to what extent the proposed alternatives would contribute to those climate change impacts. As a result, any attempt to analyze and predict the local or regional impacts of the proposed alternatives on GHG emissions cannot be done in any way that produces reliable results. On May 14, 2008, the Director of the USFWS noted, “The best scientific data available today do not allow us to draw a causal connection between GHG emissions from a given facility and effects posed to listed species or their habitats, nor are there sufficient data to establish that such impacts are reasonably certain to occur” (USFWS 2008).

Chapter 4 will quantify GHG emissions from combustion sources (both mobile and stationary sources) associated with the mining-related activities under each of the proposed alternatives.

3.2.3 Existing Air Quality

The following section describes the existing air quality within the proposed withdrawal area.

Background Air Quality and Regional Sources

There are many regional sources that may impact the Class I areas. Five permitted major point sources of air-pollutant emissions are located within 50 km (31 miles) of the proposed withdrawal area, with emissions greater than PSD thresholds (Table 3.2-4). A major source is categorized as a source that has the potential to emit more than 250 tons per year (tpy) for a PSD source, or 100 tpy for a categorical source of a criteria pollutant, or more than 10 tpy of any single hazardous air pollutant, or 25 tpy of any combination of hazardous air pollutants.

PSD sources are normally considered to have the potential for significant impacts, and more restrictive permitting requirements are generally imposed. Note that NO_x are produced during combustion, typically those that involve high combustion temperatures, and refer to nitric oxide (NO) and NO_2, respectively. Under current federal regulation [40 CFR 86, 87, 89, etc.], the affected sources listed in Table 3.2-4 will not report emissions until the first quarter of 2011, with the exception of CO_2 emissions reported by the Navajo Generating Station.

Table 3.2-4. PSD Sources Located within and near the Proposed Withdrawal Air Quality Study Area

Facility Name	Facility Type	Location in Arizona	Emissions (tpy)	Permitting Authority
El Paso Natural Gas Company – Seligman Compressor Station	Natural Gas Compressor Station	Seligman	CO – 19 NO_X – 165 PM_{10} – 4 $PM_{2.5}$ – 4 SO_2 – <1 VOCs – 4 Pb – <1	ADEQ
El Paso Natural Gas Company – Williams Compressor Station	Natural Gas Compressor Station	Williams	CO – 230 NO_X – 1,303 PM_{10} – 16 $PM_{2.5}$ – 16 SO_2 – 1 VOCs – 55 Pb – <1	ADEQ
Salt River Project – Navajo Generating Station	Electric Utility	Page	CO – 2,010 NO_X – 33,221 PM_{10} – 3,943 $PM_{2.5}$ – 2,817 SO_2 – 3,944 VOCs – 241 Pb – 0.07 CO_2 – 20.1 million	Navajo Nation Environmental Protection Agency
Chemical Lime Company – Nelson Lime Plant	Lime Plant	Peach Springs	CO – 639 NO_X – 599 PM_{10} – 480 SO_2 – 1,955 VOCs – 17 Pb – 0.0002	ADEQ

Table 3.2-4. PSD Sources Located within and near the Proposed Withdrawal Air Quality Study Area (Continued)

Facility Name	Facility Type	Location in Arizona	Emissions (tpy)	Permitting Authority
Transwestern Pipeline Company – Flagstaff Compressor Station	Natural Gas Compressor Station	Flagstaff	CO – 11 NO_X – 127 PM_{10} – 2 $PM_{2.5}$ – 2 SO_2 – 1 VOCs – 2 Pb – <1	ADEQ
Drake Cement, LLC – Drake Cement Plant	Portland Cement Plant	Drake	CO – 1,200 NO_X – 419 PM_{10} – 87 SO_2 – 22 VOCs – 39	ADEQ
Peabody Western Coal Company – Black Mesa Complex	Coal Mine	Kayenta	PM_{10} – 1,398 $PM_{2.5}$ – 325 VOCs – 9	Navajo Nation Environmental Protection Agency

Sources: ADEQ (2010c); EPA (2010j); Navajo Nation Environmental Protection Agency (2010); Western Regional Air Partnership (2010).

Note: Emissions include criteria pollutants (CO, NO_X, PM_{10}, $PM_{2.5}$, SO_2, VOCs, and Pb). Emissions data presented are for calendar year 2005 except for the Nelson Lime Plant and Black Mesa Complex, which are for calendar year 2008. Emissions data presented for Drake Cement, LLC – Drake Cement Plant represent maximum annual emissions as reported in the Standard Class I PSD Major Source Permit (Permit Number 1001770, issued on April 12, 2006). CO = carbon monoxide; NO_X = nitrogen oxides; PM_{10} = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; SO_2 = sulfur dioxide; VOCs = volatile organic compounds; Pb = lead; tpy = tons per year.

A minor source is categorized as a source having the potential to emit less than 100 tpy of a criteria pollutant, or less than 10 tpy of an individual hazardous air pollutant, or less than 25 tpy of any combination of HAPs. Minor sources located within 31 miles (50 km) of the proposed withdrawal parcels include smaller industrial and commercial operations. Additionally, there are numerous portable sources in the area, such as non-metallic mineral processing industries (e.g., portable crushing and screening plants, hot mix asphalt plants, and concrete batch plants) and the Arizona 1 Mine.

Mobile source emissions from vehicles consist of VOCs, NO_2, CO, PM_{10}, and $PM_{2.5}$, which may warrant consideration in an assessment of ambient air quality in the air quality study areas. Consideration of major traffic routes located within the air quality study areas may be reasonably limited to SR 64, which serves as the entrance to the South Rim of the Grand Canyon, and U.S. Route (U.S.) 89A through Fredonia, Arizona. Additionally, fugitive dust emissions are generated from traffic traveling on the unpaved Toroweap Road to the Tuweep district of Grand Canyon National Park. Based on information obtained from the National Park Service Public Use Statistics Office, the traffic counts in 2009 for the South District and Tuweep District were 1,122,886 and 8,659, respectively (NPS 2010).

The most recent EPA Emissions Inventory Report provides data for Coconino and Mohave counties in Arizona and Kane and Washington counties in Utah, including statewide totals, shown in Table 3.2-5. The report summarizes criteria pollutant levels in tpy by source type. These data show that the emissions in Coconino and Mohave counties, Arizona, and Kane and Washington counties, Utah, constitute a small percentage of the Arizona and Utah statewide totals.

The largest sources of NO_x and PM_{10} in Coconino and Mohave counties in Arizona and Kane County, Utah, are on-road mobile and area sources. Area sources include small portable and stationary sources such as gas stations or wood burning. The largest sources of PM_{10} in Washington County, Utah, are miscellaneous sources, which include agricultural (crop tilling and livestock dust), construction, gas stations, bulk gasoline terminals, and other miscellaneous sources.

Table 3.2-5. 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties, Arizona, Kane and Washington Counties, Utah, and Arizona Statewide

Source	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs	Pb
Coconino County							
On-road Vehicles	39,250	6,475	182	134	140	3,066	–
Electricity Generation	2,010	33,221	3,943	2,817	3,944	241	0
Non-road Equipment	12,989	3,509	204	192	269	2,933	2
Fossil Fuel Combustion	514	2,652	57	30	114	105	0
Industrial Processes	25	–	836	218	–	104	–
Fires	14,818	282	1,570	1,330	168	3,497	–
Waste Disposal	2,045	74	318	306	5	259	–
Residential Wood Combustion	348	4	48	48	1	75	–
Miscellaneous	7	0	2,045	207	–	735	0
Solvent Use	–	–	–	–	–	692	–
Road Dust	–	–	6698	594	–	–	–
Fertilizer and Livestock	–	–	–	–	–	–	–
Subtotal	*72,006*	*46,217*	*15,901*	*5,876*	*4,641*	*11,707*	*2*
Mohave County							
On-road Vehicles	43,423	7,386	208	151	160	3,862	–
Electricity Generation	7	22	1	1	3	1	–
Non-road Equipment	23,633	4,339	284	270	356	6,413	1
Fossil Fuel Combustion	174	788	66	28	149	44	0
Industrial Processes	28	32	839	214	0	28	0
Fires	14,280	313	1,551	1,314	171	3,384	–
Waste Disposal	4,437	144	550	539	4	427	–
Residential Wood Combustion	278	4	39	39	1	60	–
Miscellaneous	10	0	3,857	412	–	920	0
Solvent Use	–	–	10	9	–	1,086	–
Road Dust	–	–	2,711	231	–	–	–
Fertilizer and Livestock	–	–	–	–	–	–	–
Subtotal	*86,270*	*13,028*	*10,116*	*3,208*	*844*	*16,225*	*1*
Arizona							
On-road Vehicles	761,670	132,317	3,866	2,711	2,909	73,626	–
Electricity Generation	7,340	80,370	8,968	7,131	52,765	596	1
Non-road Equipment	458,730	64,553	5,062	4,789	6,344	50,563	33
Fossil Fuel Combustion	4,243	13,921	1,116	528	4,061	663	2
Industrial Processes	8,071	7,051	20,328	8,184	22,107	3,595	12
Fires	74,115	1,749	8,166	6,920	907	17,611	–
Waste Disposal	24,918	981	4,068	3,757	115	4,585	–
Residential Wood Combustion	15,231	183	2,097	2,066	28	3,200	–
Miscellaneous	348	33	70,344	8,635	3	19,736	0
Solvent Use	–	8	18	16	–	49,800	0
Road Dust	–	–	111,387	9,085	–	–	–
Fertilizer and Livestock	–	–	3,079	308	–	–	–
Subtotal	*1,354,666*	*301,166*	*238,499*	*54,130*	*89,239*	*223,975*	*48*
Coconino and Mohave County Percentage of Statewide Total	**11.7%**	**19.7%**	**10.9%**	**16.8%**	**6.1%**	**12.5%**	**6.3%**

Table 3.2-5. 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties, Arizona, Kane and Washington Counties, Utah, and Arizona Statewide (Continued)

Source	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs	Pb
Kane County							
On-Road Vehicles	3,490	373	10	7	9	279	–
Electricity Generation	–	–	–	–	–	–	–
Non-road Equipment	2,208	72	24	22	7	760	0
Fossil Fuel Combustion	237	46	8	4	73	9	0
Industrial Processes	1	–	17	5	–	2	–
Fires	734	11	86	76	9	156	–
Waste Disposal	1	–	0	0	–	1	–
Residential Wood Combustion	31	0	4	4	0	5	–
Miscellaneous	803	16	393	33	8	277	0
Solvent Use	–	–	–	–	–	127	–
Road Dust	–	–	631	58	–	–	–
Fertilizer and Livestock	–	–	–	–	–	–	–
Subtotal	*7,506*	*517*	*1,173*	*209*	*105*	*1,616*	*0*
Washington County							
On-Road Vehicles	22,270	3,591	78	55	87	1,771	–
Electricity Generation	16	68	2	2	2	1	–
Non-road Equipment	8,843	842	109	103	105	1,322	0
Fossil Fuel Combustion	1,180	263	36	15	138	84	0
Industrial Processes	26	8	145	45	7	31	0
Fires	11,735	311	1,354	1,155	135	2,776	–
Waste Disposal	–	–	8	0	–	23	–
Residential Wood Combustion	518	6	68	63	1	91	–
Miscellaneous	7,256	111	6,756	1,284	58	2,326	0
Solvent Use	–	–	–	–	–	1,393	–
Road Dust	–	–	1,041	80	–	–	–
Fertilizer and Livestock	–	–	–	–	–	–	–
Subtotal	*51,843*	*5,200*	*9,599*	*2,803*	*533*	*9,820*	*0*
Utah							
On-Road Vehicles	541,556	66,474	1,517	1,052	1,633	40,662	–
Electricity Generation	4,558	65,887	6,621	5,104	34,820	368	0
Non-road Equipment	170,322	27,848	1,838	1,729	2,520	26,606	4
Fossil Fuel Combustion	32,381	12,861	1,237	510	8,301	1,719	0
Industrial Processes	41,370	10,109	10,833	4,106	4,067	4,387	5
Fires	114,656	2,040	14,682	13,037	689	24,000	–
Waste Disposal	192	926	975	224	78	533	0
Residential Wood Combustion	12,031	150	1,575	1,465	23	2,124	–
Miscellaneous	46,508	700	53,803	10,141	364	21,201	0
Solvent Use	14	37	43	31	0	31,847	0
Road Dust	–	–	23,554	1,869	–	–	–
Fertilizer and Livestock	–	–	–	–	–	–	–
Subtotal	*963,586*	*187,030*	*116,677*	*39,270*	*52,496*	*153,447*	*11*
Kane and Washington County Percentage of Statewide Total	**6.2%**	**3.1%**	**9.2%**	**7.7%**	**1.2%**	**7.5%**	**2.1%**

Source: EPA (2010j).

Note: – = No data available. ; tpy = tons per year.

CO = carbon monoxide; NO_X = nitrogen oxides; PM_{10} = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; SO_2 = sulfur dioxide; VOCs = volatile organic compounds; Pb = lead.

The existing air quality in the area is expected to be typical of undeveloped regions in the western United States. Data collected in the area of the proposed withdrawal area is limited. Areas with limited ambient air quality data typically indicate that ambient pollutant levels are usually near or below detection limits. Locations vulnerable to decreasing air quality include the areas immediately surrounding surface-disturbing activities, such as energy and mineral development projects, farm tilling, and local population centers affected by residential emissions.

Specifically within the Grand Canyon National Park, peak ozone levels have been measured at just 1 part per billion (ppb) below the NAAQS. Particulate levels as measured by the Interagency Monitoring of Protected Visual Environments (IMPROVE) network are generally low, but episodic events (usually, but not always, associated with wildfires in Arizona and California) are significant. CO and NO_x levels have only been measured as part of special studies and were quite low (Martin et al. 2002). Based on 1-hour ozone concentration data obtained from the Grand Canyon National Park—The Abyss Monitor, the annual fourth-highest 8-hour ozone concentrations for 2007 through 2009 have been 69, 71, and 66 ppb, respectively (NPS Public Use Statistics Office 2010). The annual 4th-highest 8-hour ozone concentrations have flat trends, nonetheless the values are very close to the 8-hour ozone standard (0.075 ppm).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern.

Emissions from mining activities and trucks used for hauling the uranium ore to the processing areas are air quality issues. Other potential local sources of air pollution include agriculture, automobiles, generators, trains, and wood stoves/fireplaces (in winter). These sources typically generate and emit CO, NO_2, NO_x, VOCs, PM_{10}, and $PM_{2.5}$. Additionally, O_3, a highly reactive form of oxygen, forms when NO_x and VOC emissions from these sources react with sunlight on hot, still days. With the removal of leaded gasoline in the marketplace and the absence of industries such as nonferrous smelters and battery plants, airborne lead pollution is not an issue of concern in the area. In fact, the most recent lead concentration data are from Magna, Salt Lake County, Utah, for 2005, which is more than 300 miles from the proposed withdrawal parcels (EPA 2010k).

The proposed withdrawal parcels are classified as 'attainment areas' for all criteria pollutants. Only two state monitoring stations were identified within the approximately 50-km vicinity of the air quality study area. These two monitors report ambient concentrations of O_3, PM_{10}, and $PM_{2.5}$. Background air quality levels of CO, Pb, NO_2, and SO_2 were collected from the next-closest monitors that are outside the immediate 50-km air quality study area and are identified in Table 3.2-5. Refer to Figure 3.2-1 for the monitoring station locations. Concentrations are also graphically presented in Figure 3.2-2. As shown in Table 3.2-6 and Figure 3.2-2, all of the concentrations were below the NAAQS.

Radon is a colorless, chemically unreactive inert gas. The atomic radius is 1.34 angstroms, and it is the heaviest known gas—radon is nine times denser than air. Radon is also fairly soluble in water and organic solvents. Although reaction with other compounds is comparatively rare, it is not completely inert and forms stable molecules with highly electronegative materials. Radon is considered a noble gas that occurs in several isotopic forms. Only two are found in significant concentrations in the human environment: radon-222 and radon-220. Radon-222 is a member of the radioactive decay chain of uranium-238. Radon-220 is formed in the decay chain of thorium-232. Radon-222 decays in a sequence of radionuclides called radon decay products, radon daughters, or radon progeny. It is radon-222 that most readily occurs in the environment. Atmospheric releases of radon-222 result in the formation of decay products that are radioisotopes of heavy metals (polonium, lead, bismuth) and rapidly attach to other airborne materials, such as dust and other materials, facilitating inhalation.

Table 3.2-6. 2008 Air Quality Monitor Data from the Air Quality Study Area

Pollutant	Averaging Period	Measured Concentration (Maximum Value)	Monitor Site ID/Name (County)	Source	Primary NAAQS
CO	1-hour	4.2 ppm	320030538	EPA	35 ppm (40 mg/m^3)
	8-hour	2.5 ppm	Las Vegas, NV (Clark County)		9 ppm (10 mg/m^3)
Pb*	Rolling 3-Month Average	–	–	–	–
	Quarterly Average	–	–	–	–
NO_2	1-hour	0.064 ppm	3200332002	EPA	0.100 ppm
	Annual	0.016 ppm	Las Vegas, NV (Clark County)		0.053 ppm (100 µg/m^3)
PM_{10}	24-hour	45 µg/m^3	04-005-1008 Flagstaff Middle School, AZ (Coconino County)	ADEQ	150 µg/m^3
$PM_{2.5}$	24-hour	13.5 µg/m^3	04-005-1008	ADEQ	35 µg/m^3
	Annual	5.92 µg/m^3	Flagstaff Middle School, AZ (Coconino County)		15.0 µg/m^3
O_3	1-hour	0.078 ppm	04-005-8001	ADEQ	0.12 ppm
	8-hour	0.073 ppm	Grand Canyon NP – The Abyss (Coconino County)		0.075 ppm (2008 standard)
SO_2	3-hour	0.002 ppm	320030539	EPA	0.5 ppm
	24-hour	0.002 ppm	Las Vegas, NV		0.14 ppm
	Annual	0.001 ppm	(Clark County)		0.03 ppm

Sources: ADEQ (2009a); EPA (2010k).

Note: – = No data available; ppm = parts per million; µg/m^3 = micrograms per cubic meter; CO = carbon monoxide; Pb = lead; NO_2 = nitrogen dioxide; PM_{10} = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; 0_3 = ozone; SO_2 = sulfur dioxide.

* Ambient lead monitoring data not available for the study area. Nearest monitoring occurs in Magna, Utah.

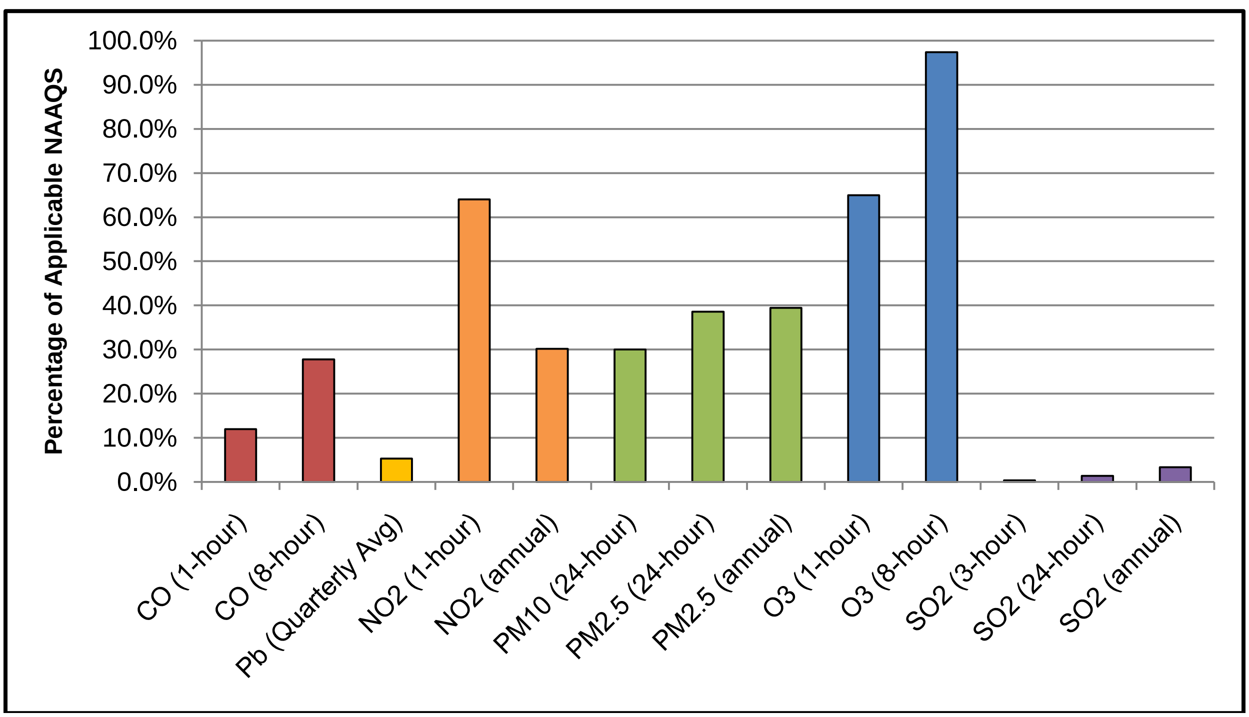


Figure 3.2-2. Background concentrations of criteria pollutants from the air quality study area.

People may ingest trace amounts of radon with food and water. However, inhalation is the main route of entry into the body for radon and its decay products. Radon decay products may attach to particulates and aerosols. When they are inhaled, some of these particles are retained in the lungs. Almost all risk from radon comes from breathing air with radon and its decay products. Radon decay products cause lung cancer. The health risk of ingesting radon, in water, for example, is dwarfed by the risk of inhaling radon and its decay products. They occur in indoor air or with tobacco smoke. Alpha radiation directly causes damage to sensitive lung tissue. Most of the radiation dose is not actually from radon itself, however, which is mostly exhaled. It comes from radon's chain of short-lived solid decay products, which are inhaled on dust particles and lodge in the airways of the lungs. These radionuclides decay quickly, producing other radionuclides that continue damaging the lung tissue.

There have been historical issues with radioactive fallout within the withdrawal parcels. The nuclear testing conducted at the Nevada Test Site in the 1940s and 1950s dispersed radioactive material into the atmosphere. This radioactive material was then deposited as radioactive fallout. This radioactive fallout accounts for much of the background radiation in the area.

The natural background radon gas concentration in the vicinity of the Arizona 1 Mine is on the order of 0.2 picocuries per liter (pCi/L), or 125 mrem/yr. Based on previous evaluations of the project (McKlveen 1988), the highest potential exposure projected from radon would be on the order of 106 mrem/yr (ADEQ 2008).

Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the mine life of ore production) and cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (ADEQ 2010a). To put the 10 millirem in context, a typical chest x-ray is approximately 10 millirem per film and smoking one and a half packs of cigarettes daily exposes an individual to approximately 1,300 millirem per year (Cancer Information Service 2001).

The ADEQ-issued Air Quality Permit for the Arizona 1 Mine requires Denison to keep records of all emission related activities and submit for approval a dust control plan that requires them to monitor and track ongoing implementation of dust control measures. Additionally, radon emissions from the vent shaft must be monitored and sent to ADEQ for review (Table 3.2-7).

Table 3.2-7. Arizona 1 Mine Potential to Emit (tpy)

CO	NO_x	PM_{10}*	$PM_{2.5}$	SO_2	VOCs	Radon†
0.28	1.3	324.44	5.7	0.08	0.38	–

Source: ADEQ (2010a).

Note: – = No data available; tpy = tons per year. CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a nominal aerodynamic diameter of less than 10 micrometers; $PM_{2.5}$ = fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers; SO_2 = sulfur dioxide; VOCs = volatile organic compounds.

* Includes fugitive emissions, which are not considered in PSD applicability.

† Potential to emit was based on permissible thresholds promulgated in 40 CFR 61.22.

ADEQ required Denison to conduct ambient air dispersion modeling to ensure that emissions from the Arizona 1 Mine would not cause or contribute to an exceedance of the federal NAAQS for particulate matter. ADEQ required that Denison include the 37 miles of unpaved road used by the haul trucks in this analysis.

Visibility

Visibility is the degree to which the atmosphere is transparent to visible light. It is an important air quality value, particularly in scenic and recreational areas. Scenic vistas in most U.S. parklands can be diminished by haze that reduces contrast, dilutes colors, and reduces the distinctness or visibility of distant landscape features. Visibility degradation in national park lands and forests is a consequence of broader, regional-scale visibility impairment from visibility-reducing particles and their precursors, which are often carried long distances to these remote locations (NPS 2007).

Sulfates, organic matter, elemental carbon (soot), nitrogen compounds, soil dust, and their interaction with water cause most anthropogenic visibility impairment. The causes and severity of visibility impairment vary over time and space, depending on meteorological conditions, sunlight, and the size and proximity of emission sources.

Visibility protection requirements are included in EPA PSD regulations requiring protection of AQRVs for Class I areas. In the PSD title of the CAA, "Congress declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution." More specifically, Congress expressed the national desire to preserve the ability to see long distances, entire panoramas, and specific features associated with the statutory Class I areas (NPS 2010). Meeting these visibility objectives occurs when "reasonable progress" is made toward achieving EPA's regional haze regulation goal of restoring natural background visibility conditions by 2064 (EPA 2003a).

The Cooperative Institute for Research in the Atmosphere operates a network of visibility monitoring stations in or near Class I areas and publishes IMPROVE data. The purpose of this monitoring is to identify and evaluate patterns and trends in regional visibility. Data from three IMPROVE monitors within Grand Canyon National Park show that fine ($PM_{2.5}$) and coarse (PM_{10}) particulates were the largest contributors to the impairment of visibility. These particulates impact the standard visual range for each monitor location. The standard visual range is the distance that can be seen in a given day. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park (GRCA1, GRCA2, and INGA1) range from 149 to 178 mile on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days (IMPROVE 2010).

A change in contrast of not more than 5% at sensitive view areas is considered acceptable. As discussed in the previous section, Bryce Canyon, Zion, and Grand Canyon national parks (all Class I) and Grand Canyon–Parashant National Monument, Glen Canyon and Lake Mead National Recreation Areas, and Paria Canyon–Vermilion Cliffs and Kanab Creek wilderness (Class II) are in close proximity to the proposed withdrawal parcels.

The State of Arizona has addressed both visibility and regional haze in the Class I areas within its State Implementation Plan (SIP). The Regional Haze SIP for the State of Arizona (ADEQ 2003) addresses visibility protection of Arizona's natural features using various long-term strategies addressing the clean air corridor, stationary sources, mobile sources, and fire programs.

More current information is available in the Air Quality Division Revision SIP for Regional Haze (ADEQ 2004). These documents contain measures addressing regional haze visibility impairment to ensure that the State makes reasonable progress toward national goals. The State has implemented long-term strategies to reduce regional haze resulting from various air pollution sources. Pollutant projections affecting regional haze, as identified in the 2004 revised SIP, include the following:

- A 36% decrease in Arizona sources and a 22% decrease for nine Grand Canyon Visibility Transport Commission region states' (Arizona, California, Colorado, Idaho, New Mexico, Nevada, Oregon, Utah, and Wyoming) SO_2 emissions between 1996 and 2018.

- A 16% decrease in Arizona sources and 32% decrease for nine Grand Canyon Visibility Transport Commission states' NO_x emissions between 1996 and 2018.
- A 3% decrease in Arizona sources and 3% increase for nine Grand Canyon Visibility Transport Commission region states' $PM_{2.5}$ emissions between 1996 and 2018.
- A 25% decrease in Arizona sources and 30% decrease for nine Grand Canyon Visibility Transport Commission region states' VOC emissions between 1996 and 2018.
- Visibility improvement for the 20% best and worst days for each of the Class I areas (Bryce Canyon, Zion, and the Grand Canyon) from the base year 1996 to the year 2018.

The State of Arizona's reduction in SO_2 is due primarily to the long-term reduction strategy for stationary sources of SO_2. The reduction in NO_X and $PM_{2.5}$ is due primarily to the implementation of new federal engine and fuel standards.

Resource Condition Indicators

Air quality related to uranium mining activities results from initial heavy-duty construction equipment operations/earthmoving (e.g., trucks backhoes, excavators, etc.) and long-term from production operations (e.g., ore/waste rock handling, travel on unpaved roads, etc.). To properly evaluate any potential air quality effects that could be caused by an individual proposed mine or a number of proposed mines, each mine would need to be evaluated/modeled using the specific mine site location, number and types of equipment, operation schedules, site-specific topography, and meteorological data.

Resource Condition Indicators

The air quality condition indicators to be evaluated in Chapter 4 of this assessment area as follows:

- Discussion of the potential increases in ambient concentrations in air pollutants associated with mine exploration and mining activities to determine compliance with applicable Federal, state, and local regulations;
- The estimated quantity of HAPs emitted under each alternative;
- Discussion of the potential increases in ambient concentrations in air pollutants associated with mine exploration and mining activities Comparison of the maximum NO_X, CO, PM_{10}, and SO_2 concentrations with the NAAQS;
- Discussion of potential increases in NO_X, CO, PM_{10}, and SO_2 concentrations with the PSD air quality increments;
- The estimated quantity of GHG emissions emitted under each alternative, and;
- Discussion of potential impacts in AQRVs relating to visibility.

To assess the current value of the resource condition indicators, the applicant of an individual proposed mine would be required to obtain an air quality permit from ADEQ. Depending on what class of permit would be required and/or the requests of the Department the applicant may be required to estimate its emissions and conduct modeling. The ADEQ Air Quality Division issues air quality permits to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air.

3.2.4 Current Value Resource Condition Indicators

The current value or condition of the air quality within the study area with respect to each of the resource condition indicators is presented in Table 3.2-8.

Table 3.2-8. Air Quality Resource Condition Indicators

Issue	Description of Relevant Issue	Resource Condition Indicator(s)
Quantity of criteria and hazardous air pollutants	The emissions from the emergency backup generator and the ore, waste rock unloading, and fugitive dust emissions from unpaved haul road travel associated with the Arizona 1 Mine are presented in Table 3.2-7. Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year or 100,000 tons over the life of the mine of ore production) and cannot exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (ADEQ 2010a). A regulated uranium mine under 40 CFR Part 61 Subpart B must submit an application and annual Subpart B compliance reports to the EPA.	Quantity of criteria and hazardous air pollutants emitted under each alternative.
Regulatory Requirements	Each individual mine will be required to obtain an air quality permit. The permit is the mechanism to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air.	PSD: > 250 tpy of a criteria pollutant Federal HAP Source: > 25 tpy combined or > 10 tpy of a regulated HAP ADEQ Class I Source: > 100 tpy to < 250 tpy of a criteria pollutant ADEQ Class II Source: > 2 tpy to < 100 tpy of a criteria pollutant
NAAQS	As shown in Table 3.2-6 and Figure 3.2-2, the ambient air concentration data obtained from monitors in or near the air quality study area were below the NAAQS. However, based on data obtained from the Grand Canyon National Park, the annual 4th-highest 8-hour ozone concentrations have flat trends nonetheless have values that are very close to 8-hour ozone standard (0.075 ppm) and sometimes over it (NPS 2010).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern. The EPA recommends that this proposed “secondary” standard be in the range of 7 to 21 ppm-hours.	Comparison of measured and/or modeled air pollutant concentrations with applicable thresholds (i.e., NAAQS).
PSD Increment	The PSD increments establish the maximum increase in pollutant concentration allowed above the baseline level.	PSD is the mechanism that protects Class I areas.
GHGs	Qualitative and/or quantitative evaluations of potential contributing factors within the planning area will be included in Chapter 4 where appropriate and practicable.	The quantity of GHG emission emitted under each alternative.
AQRVs – Visibility	The NPS has classified the visibility at the Grand Canyon National Park as a stable moderate concern. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days.	Discussion of visibility impacts and comparison of measured or modeled values with applicable thresholds.

3.3 GEOLOGY AND MINERAL RESOURCES

3.3.1 Geological Setting

Physiography

The proposed withdrawal area lies within the Colorado Plateau physiographic province in northern Arizona. The Colorado Plateau covers more than 130,000 square miles and is centered on the Four Corners area. The portion of the Colorado Plateau province that includes the proposed withdrawal area is characterized by predominantly sedimentary rock exposures; a regular, gently dipping surface; and plateaus over 7,000 feet above mean sea level (amsl) that have been incised in some places to depths over 5,000 feet by the tributaries to the Colorado River. Major geological structures that occur in the proposed withdrawal area include faults, anticlines, and monoclines. These structures often form the geographic boundaries for the numerous plateaus located throughout the area proposed withdrawal, and are shown in Figure 3.4-5 in Section 3.4, Water Resources.

The Colorado Plateau is known generally for unique geological features, including the widespread prevalence and color of exposed sedimentary units, the occurrence of isolated volcanic mountain complexes, and erosional features such as mesas, cliffs, escarpments, and incised stream canyons. While not within any of the parcels, the Grand Canyon dominates the geological setting and forms the partial geographic boundary of the East Parcel; the side tributary canyons to the Grand Canyon form the surface drainage network within the parcels.

The major geological structures and geographic features of the North Parcel include the Uinkaret and Kanab plateaus (see Figure 3.4-5). The Uinkaret Plateau extends east from the Hurricane fault zone to the Toroweap fault zone. The Kanab Plateau then extends east from the Toroweap fault zone to the Muav fault zone. These fault zones are largely northerly trending normal faults, downthrown to the west. The Kanab Plateau has also been dissected by Kanab Creek, a tributary to the Colorado River, as well as other tributaries to Kanab Creek, including Hack Canyon, Grama Canyon, and Snake Gulch.

House Rock Valley, where the East Parcel is located, is a geological basin bounded to the west by the East Kaibab monocline, which is the eastern edge of the Kaibab Plateau, to the north by the Vermilion Cliffs, which is the edge of the Paria Plateau, and to the southeast by Marble Canyon, part of the Colorado River gorge (see Figure 3.4-5).

The South Parcel lies completely within the Coconino Plateau, the largest of the plateaus within northern Arizona (see Figure 3.4-5). Major structural features within the South Parcel include the Grandview monocline, East Kaibab monocline, Cataract syncline, and Bright Angel fault.

The unique geological and topographic features of the Grand Canyon were cited as specific criteria for its designation as a World Heritage Site:

> Widely known for its exceptional natural beauty and considered one of the world’s most visually powerful landscapes. . . . Within park boundaries, the geologic record spans all four eras of the earth’s evolutionary history, from the Precambrian to the Cenozoic. The Precambrian and Paleozoic portions of this record are particularly well exposed in canyon walls and include a rich fossil assemblage. Numerous caves shelter fossils and animal remains that extend the paleontological record into the Pleistocene. (United Nations Educational, Scientific, and Cultural Organization 2010)

Stratigraphy

In terms of geology, the Colorado Plateau in northern Arizona is composed of relatively flat layers of sedimentary rocks of Paleozoic and Mesozoic age deposited on top of Precambrian basement rocks, although in some places more recent Tertiary volcanic activity has created isolated mountains or cinder cones (such as the San Francisco Peaks or Mt. Trumbull). The general stratigraphy of the Colorado Plateau is shown in Figures 3.4-3 and 3.4-4. Specific geological units are discussed in detail in Section 3.4, Water Resources, as the primary importance of these units is their influence on local and regional hydrology.

Paleontology

Geological units representing nearly 2 billion years of time are present in the proposed withdrawal area, although many are not exposed at the surface. Many of these units are sedimentary in nature, and some contain paleontological resources. The potential for a given geological formation to contain paleontological resources varies by formation age and deposition type. The geological units that contain paleontological resources range from 570 million years to about 10,000 years old.

The paleontological resources within the proposed withdrawal area are widespread and associated with extensive geological formations. These paleontological resources are typically small in size, common in nature, and ubiquitous. Paleontological resources of a highly unique nature are not common within the proposed withdrawal area; for this reason, while some subsurface impact to unexposed paleontological resources could occur from mining activities, it is not of a level sufficient to include in the analysis.

Mineral Deposits

Minerals of economic interest are classified as leasable, locatable, or salable. Coal, oil shale, oil and gas, phosphate, potash, sodium, geothermal resources, and all other minerals that may be acquired under the Mineral Leasing Act of 1920, as amended, are referred to as leasable minerals. Common varieties of sand, stone, gravel, pumicite, and clay that may be acquired under the Materials Act of 1947 are considered salable minerals or mineral materials. Any minerals that are not salable or leasable, such as gold, silver, copper, tungsten, and uranium, are referred to as locatable minerals. These mineral deposits include most metallic mineral deposits and certain nonmetallic and industrial minerals. Locatable minerals are subject to the Mining Law. The primary geological environments within the proposed withdrawal area with the potential for locatable minerals are breccia pipe–related deposits. Favorable environments also occur for non-metallic industrial minerals such as gypsum. Only locatable mineral resources are subject to the proposed withdrawal. Therefore, leasable and salable mineral resource occurrence and development are not discussed further, although they are considered in Chapter 4 in the context of cumulative impacts.

Locatable Minerals

The primary economic mineral resource within the proposed withdrawal area consists of locatable mineral deposits, including both stratabound deposits and breccia pipe deposits.

Gypsum deposits are found in northern Arizona associated largely with the Toroweap, Kaibab, and Moenkopi formations. No specific gypsum deposits are known to exist within the proposed withdrawal area, although several tons of alabaster were quarried for ornamental carving from one known location on the North Parcel, which has since been reclaimed. The BLM mineral potential report for the proposed withdrawal area indicates the potential for gypsum occurrence is Low, with a moderate level of certainty (BLM 2010a). Metallic minerals associated with stratabound deposits occur only on the South Parcel, which contains primarily copper in the Francis mining district. Secondary copper minerals, including azurite, chrysocolla, and malachite, are located within siliceous brecciated horizons of Kaibab Limestone (Scott 1992). These deposits were studied and considered small and unattractive for commercial development (Scott 1992).

All other locatable deposits of economic interest are associated entirely with geological features known as breccia pipes. Breccia pipes are vertical collapse features formed from the collapse of karst solution caverns in the Redwall Limestone. As the collapse feature migrated upward from the Redwall, a vertical pipe formed, extending several thousand feet through the overlying sedimentary formations, and within this pipe, breccia formed from broken pieces of the overlying formations. Breccia pipes are quite small, typically averaging only 300 feet in diameter. Subsequent intrusion of mineralized groundwater into the breccia pipes resulted in the precipitation of various minerals within the pipes; while thousands of pipes exist across the Colorado Plateau, it has been estimated that perhaps less than 1% contain levels of mineralization suitable for mining (Wenrich and Sutphin 1988).

A variety of metals are found within breccia pipes. Early prospectors were drawn to exposures of these minerals where breccia pipes had been eroded along the walls of incised canyons, such as the Orphan Mine, which is located on the south rim of the Grand Canyon itself. Precious metals include copper, gold, silver, and vanadium. However, it is the presence of uranium minerals within breccia pipes that has been of the most interest over the past half century. From the 1950s through the 1980s, 12 breccia pipes were mined specifically for their uranium deposits; several other mines were constructed and placed on interim management status in the 1990s partially as a result of low commodity prices. The uranium deposits within the northern Arizona breccia pipes are of higher grade than approximately 85% of the world's known uranium deposits (International Atomic Energy Agency 2009; World Nuclear Association 2010a).

While breccia pipes can have a surface exposure formed by the collapse and tilting of the overlying sedimentary beds, confirmation of the presence of a breccia pipe is typically only possible through drilling. Approximately 45 breccia pipes have been confirmed through drilling within the proposed withdrawal area (see RFD, Appendix B, Table B-1). Uranium reserves are typically expressed in relation to the naturally occurring mineral pitchblende (U_3O_8). Known reserves of uranium (U_3O_8) within these pipes amount to 10,658 tons, as shown in Table 3.3-1. Note that the term "uranium resources" used in this section is a generic term that encompasses all ore bodies, even ones not yet discovered; by contrast, the term "uranium reserves" refers to confirmed ore bodies that are both economically and technically feasible to mine.

Table 3.3-1. Estimated Known Reserves, Undiscovered Uranium Endowment, and Estimated Total Available Uranium Resources

Parcel	Confirmed Breccia Pipes*	Known Uranium Reserves (tons U_3O_8)*	Estimated Uranium Resources in Discovered Pipes not yet Quantified (tons U_3O_8)†	Undiscovered Uranium Endowment (tons U_3O_8)‡	Estimated Total Available Uranium Resources (tons U_3O_8)§
North	30	8,700	3,000	91,944	25,491
East	1	0	0	22,257	3,339
South	14	1,958	1,500	49,179	10,835
Totals	**45**	**10,658**	**4,500**	**163,380**	**39,666**

* Personal communication, E. Spiering, Quaterra Resources, Inc. (2010). Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 to account for this discrepancy.

† Based on 15% of discovered mineralized breccia pipes containing ore bodies, each ore body averaging 1,500 tons.

‡ USGS (2010b).

§ Includes known uranium reserves (Arizona 1, Pinenut, Rim, Kanab North, EZ1, EZ2, DB, Findlay Tank NW, Findlay Tank SE, Canyon, What), estimated uranium resources in known mineralized pipes, and 15% of undiscovered uranium endowment (see RFD, Appendix B, Table B4).

While the entirety of the proposed withdrawal area has a high potential for the presence of breccia pipe deposits, approximately 82% (8,700 tons) of these known reserves occur within the North Parcel. No confirmed reserves are located within the East Parcel, and only 1,958 tons are confirmed within the South Parcel. Note that uranium tonnage refers to the estimated amount of uranium after processing at the mill; the amount of ore needed to be removed from the mine and transported to the mill for processing would typically be 100 to 200 times greater than the noted tonnage of processed uranium.

With respect to undiscovered uranium resources, in 1987 the USGS divided northern Arizona into areas of varying favorability for uranium resources (Finch et al. 1990). The study area for the 1987 estimate covered over 16,700 square miles, and of this area approximately 9,100 square miles were considered to be "Favorable Area A," the area with the highest potential for breccia pipes to occur (Figure 3.3-1). Almost the entire proposed withdrawal area falls within the area considered to be high potential. Similarly, the mineral report produced by the BLM for the proposed withdrawal area rates the potential for uranium occurrence as high, with a high level of certainty (BLM 2010a).

In addition to uranium reserves confirmed through drilling, the USGS has estimated the amount of undiscovered uranium endowment within the proposed withdrawal area, as shown in Table 3.3-1. The term "endowment" refers specifically to rocks containing uranium exceeding a grade of 0.01% but does not indicate whether the uranium ore can be mined economically. Historically, the mines within the proposed withdrawal area have not contained average uranium concentrations less than 0.5% U_3O_8 (personal communication, Spiering 2010). The percentage of the uranium endowment that might be economically mined has not been determined by the USGS; for the purposes of the RFD (see Appendix B), it was assumed that 15% of the endowment might be mined. This percentage of the estimated endowment (24,507 tons U_3O_8), the amount of confirmed uranium reserves (10,658 tons U_3O_8), and the uranium estimated to be in breccia pipes already discovered (4,500 tons U_3O_8) represent the total estimated uranium resource within the proposed withdrawal area (39,666 tons U_3O_8), as shown in Table 3.3-1.

3.3.2 Resource Condition Indicators

Resource condition indicators for mineral resources include the following:

- Availability of high mineral potential lands.
- Number of ore deposits mined.
- Potential for subsidence and alteration of geology or topography.
- Amount of uranium mined as percentage of known domestic resources, current domestic demand, and current domestic production.
- Depletion of uranium resources within proposed withdrawal area.
- Amount of uranium mined as percentage of global demand and production.
- Cumulative amount of high-potential uranium resource lands withdrawn from exploration and development.

Following is a discussion of the current value or condition with respect to each of the resource condition indicators listed above.

Availability of High Mineral Potential Lands

The approximately 1 million acres of land within the proposed withdrawal area are considered to have high mineral potential for uranium. The resource condition indicator is the availability of these high mineral potential lands. The current value is that these lands have historically been fully available for exploration and possible development of economic mineral deposits.

Number of Ore Deposits Currently under Approved Plans of Operation

The majority of exploration and development activity associated with breccia pipe uranium deposits within the proposed withdrawal area occurred during the 1980s. During this period, five breccia pipes were mined for recoverable uranium resources on the North Parcel, including the Hack 1, Hack 2, Hack 3, Hermit, and Pigeon pipes. Four additional mines within the proposed withdrawal area were partially developed but placed under interim management when uranium commodity prices collapsed.

These include the Pinenut, Arizona 1, and Kanab North mines on the North Parcel and the Canyon Mine on the South Parcel. Some uranium ore was mined from both the Pinenut and Kanab North mines. The Arizona 1 mine restarted mining operations in December 2009.

The resource condition indicator is the number of ore deposits operating under approved mine plans of operation. The current value of this resource condition indicator is four: Pinenut, Arizona 1, Kanab North, and Canyon.

Potential for Subsidence and Alteration of Geology or Topography

Mining of any type alters the natural geological formations and topography. The Grand Canyon region is notable for its prominent and unique geology and striking topography, both of which could be altered by mining. This includes the potential for collapse or subsidence of reclaimed or active mine sites and alteration of the area’s topography (streams, canyon walls, mesas, or knolls) and/or geology by mines.

Mining of breccia pipes is conducted through underground workings; uranium minerals in breccia pipes typically occur a thousand feet or more below ground and are accessed by a central vertical shaft, allowing for a relatively small mine footprint (typically 20 acres or less). Earlier discoveries, where minerals were exposed along the walls of incised canyons (such as Orphan Mine) also mined using horizontal shafts to reach the ore bodies. Several useful case studies of mined breccia pipes are available to estimate the potential for breccia pipe mines to subside or alter the geology of the area. These include the Orphan, Hack Canyon, Hack Canyon Complex, Pigeon, and Hermit mines; as examples, these represent mining under historic conditions (Orphan Mine and the original Hack Canyon Mine), as well as more modern mining and reclamation techniques (Hack Canyon Complex, Pigeon, and Hermit), in addition to representing three of the most productive breccia pipes mined in northern Arizona (Orphan, Hack 2, and Pigeon).

ORPHAN MINE

The Orphan pipe was discovered as a mineral exposure on a canyon wall of the Grand Canyon and was mined from the side of the canyon, as well as through a vertical shaft from the South Rim; descriptions of mine techniques are provided by Chenoweth (1986). Uranium mining from the Orphan mine began in 1956, and approximately 500,000 tons of dry ore were removed from the Orphan Mine. Mining was conducted almost entirely underground, with the exception of head structures, and included the central breccia pipe as well as the surrounding ring fractures. Mining took place to a depth of approximately 600 feet, using a series of circular tunnels, shafts, and stopes. Most of the ore bodies mined ranged from 15 to 60 feet wide. Mining ceased in 1969. Surface evidence of the mine still exists within Grand Canyon National Park in the form of open, vertical shafts. The head structure was removed from the mine in 2009. No evidence of subsidence resulting from the mining has been identified.

HACK CANYON MINES

The original Hack Canyon mine was similarly discovered as a mineral exposure at the base of the canyon wall in Hack Canyon and was mined from the floor of the canyon; descriptions of mine techniques are provided by Chenoweth (1988). Uranium mining from the Hack Canyon mine began in 1950, and approximately 1,400 tons of dry ore were removed from the Hack Canyon mine. Mining was conducted entirely underground through several vertical shafts, horizontal tunnels, and stopes, to a depth of approximately 100 feet. Mining ceased in 1964.

In the 1970s and 1980s, three additional breccia pipes were discovered in the vicinity (Hack 1, Hack 2, and Hack 3 and known collectively as the Hack Canyon Complex). All three breccia pipes were mined for uranium from approximately 1981 through 1987 (USGS 2010b), resulting in the removal of approximately 742,000 tons of dry ore (Hack 1 – 134,000 tons, Hack 2 – 479,000 tons, Hack 3 – 111,000 tons) (personal communication, E. Spiering, Quaterra Resources, Inc. 2010). Reclamation of all three of these pipes, as well as the historic Hack Canyon workings, was completed in 1988. No evidence of subsidence resulting from the mining has been identified.

PIGEON MINE

The Pigeon Mine is located immediately north of the edge of Snake Gulch, a tributary to Kanab Creek, but unlike the Orphan and original Hack Canyon Mine, the mine was not identified through mineral exposure along the canyon wall. The Pigeon Mine is more typical of breccia pipes that would be mined under present-day conditions, as it involved a single vertical shaft to access the uranium ore body. Approximately 440,000 tons of dry ore were removed from the Pigeon Mine (USGS 2010b). Mining was conducted entirely underground, with surface access through a single vertical shaft. Surface features included a wastewater pond, head structures, and waste rock piles. Mining ceased in 1989. The site has been reclaimed, including the restoration of the natural drainage and returning the topography close to its natural state. No evidence of subsidence resulting from the mining has been identified.

HERMIT MINE

The Hermit Mine is located approximately 10 miles west of Kanab Creek, and is similar to the Pigeon Mine as being typical of breccia pipes that would be mined under present-day conditions. Approximately 36,000 tons of ore were removed from the Hermit mine (USGS 2010b). Mining was conducted entirely underground, with surface access through a single vertical shaft. Surface features included a wastewater pond, head structures, and waste rock piles. Mining ceased in 1989. The site has been reclaimed, including the restoration of the natural drainage and returning the topography close to its natural state. No evidence of subsidence resulting from the mining has been identified.

Amount of Uranium Mined as Percentage of Known Domestic Resources, Domestic Demand, and Domestic Production

Domestic uranium reserves or resources are difficult to estimate. The U.S. Energy Information Administration (EIA) last completed a domestic uranium reserve summary in 2008, based on analysis of historical data and information reported by uranium mining companies. This estimate indicates that domestic uranium reserves total 269,500 tons U_3O_8; it should be noted that the 2008 estimate is dependent on uranium price, and the number shown is based on a commodity price of $50/pound (EIA 2011a). These represent geological reserves only; uranium stockpiles from other sources are not included in this estimate. Other available estimates include a 2007 estimate by the World Nuclear Association, which indicates U.S. domestic reserves of 403,000 tons U_3O_8 (World Nuclear Association 2010a).

Total domestic production of uranium (for 2009) was 3.75 million pounds U_3O_8, or 1,875 tons U_3O_8 (EIA 2010a), from 14 underground mines and four in-situ leaching plants located primarily in Wyoming, Nebraska, Texas, Colorado, and Utah. The total current domestic uranium requirement for nuclear reactors (projected for 2010) was 23,040 tons U_3O_8 (World Nuclear Association 2011). Current production within the proposed withdrawal area occurs solely from the Arizona 1 mine, which has an estimated total uranium reserve of 1,228 tons U_3O_8.

The resource condition indicator consists of the percentage of known domestic uranium reserves, domestic production, and domestic demand that is accounted for by mining within the proposed withdrawal area. Currently, the actively mined reserves of the Arizona 1 mine, taken as a whole, represent approximately 0.1% of the estimated domestic uranium reserve, 65% of total 2009 domestic uranium production, and 2% of the projected domestic reactor requirement for 2010.

Depletion of Uranium Resources within Withdrawal Area

Uranium resources, once mined, are permanently depleted and unavailable for future mining. The resource condition indicator consists of the percent removal or depletion of estimated uranium resources within the withdrawal area. The estimated amount of uranium resources within the withdrawal area is 39,666 tons U_3O_8 (see Table 3.3-1). Currently, once the actively mined reserves of the Arizona 1 mine are depleted, they will represent a 3.1% reduction in the amount of uranium reserves available within the withdrawal area.

Amount of Uranium Mined as Percent of Global Demand and Production

Total global production of uranium (for 2008) was approximately 114 million pounds U_3O_8, or 57,000 tons U_3O_8 (TradeTech 2010). The total global uranium requirement (for 2008) was approximately 168 million pounds U_3O_8, or 84,000 tons U_3O_8 (TradeTech 2010). Current production within the proposed withdrawal area occurs solely from the Arizona 1 mine, which has an estimated total uranium reserve of 1,228 tons.

The resource condition indicator consists of the percentage of global production and global demand that is accounted for by mining within the proposed withdrawal area. Currently, the actively mined reserves of the Arizona 1 mine, taken as a whole, represent approximately 2.1% of total 2008 global uranium production and 1.5% of the total 2008 global uranium demand.

Cumulative Withdrawal of High Mineral Potential Lands

Based on the 1987 USGS estimate, approximately 9,100 square miles were considered to be “Favorable Area A,” the area with the highest potential for breccia pipes to occur.

Previous withdrawals have removed portions of the following high mineral potential lands from mineral location and entry (see Figure 2.4-1 and Table 2.4-1):

- Grand Canyon National Park, covering approximately 1,900 square miles: approximately 60% is considered high mineral potential.
- Grand Canyon–Parashant National Monument, covering approximately 1,600 square miles: approximately 25% is considered high mineral potential.
- Kanab Creek Wilderness Area, covering approximately 118 square miles: approximately 70% is considered high mineral potential.

- Saddle Mountain Wilderness Area, covering approximately 63 square miles: approximately 90% is considered high mineral potential.
- Grand Canyon Game Preserve, covering approximately 1,000 square miles (inclusive of Kanab Creek and Saddle Mountain Wilderness Areas): approximately 90% is considered high mineral potential.
- Paria Canyon–Vermilion Cliffs Wilderness Area, covering approximately 176 square miles: approximately 95% is considered high mineral potential.
- Navajo Nation. The Navajo Nation covers almost 26,000 square miles; approximately 1,600 square miles of the west side of the Navajo Nation is considered high mineral potential.
- Havasupai Tribe, covering approximately 250 square miles: approximately 80% is considered high mineral potential.
- Hualapai Tribal Nation, covering approximately 1,560 square miles: approximately 30% is considered high mineral potential.
- Kaibab Band of Paiute, covering approximately 200 square miles: approximately 50% is considered high mineral potential.

In all, approximately 5,100 square miles of high mineral potential lands have previously been withdrawn, accounting for approximately 56% of the high mineral potential lands identified by the USGS in northern Arizona and southern Utah (i.e., 56% of Favorable Area A from Finch et al. 1990).

3.4 WATER RESOURCES

The focus of this section is existing water resource conditions in the vicinity of the proposed withdrawal area and the resource condition indicators that will be the basis for evaluating potential impacts under each of the alternatives in Chapter 4. The relevant resources for this analysis include surface water, groundwater, and the interaction between these two resources. This analysis is based on review and compilation of available data for selected hydrologic parameters; information in the files of the BLM, NPS, Arizona Department of Water Resources (ADWR), Forest Service, ADEQ, ASLD, and AZGS; interviews with representatives of the mining companies that have operated mining facilities in the proposed withdrawal area; and review of information from numerous previous investigations of the Grand Canyon region, including those by the USGS, several universities, Errol L. Montgomery and Associates (Montgomery), and other environmental consultants.

3.4.1 General Description of Study Area

The study area for the water resources analysis is indicated in the inset map on Figure 3.4-1. This figure also shows the proposed withdrawal area boundaries, land ownership, uranium mine sites, and mining claims. The study area for the water resources analysis was selected to include local surface water drainage areas and groundwater basins that could potentially be impacted by reasonably foreseeable activities in the proposed withdrawal area. Additional areas remote from the proposed withdrawal area, such as the Virgin River in Utah and near Littlefield, Arizona, were also considered because of potential hydrologic connections. Figure 3.4-2 (from Beus and Morales 2003) is a generalized map that shows the major plateaus in the area surrounding the Grand Canyon.

Different amounts and types of water resources information are available for each of the three parcels. In general, more water resources investigations have been conducted for the region south of the Grand Canyon than to the north. The studies for the South Parcel and adjacent areas south of the Grand Canyon include other large-scale EISs and a numerical groundwater flow model for the Coconino Plateau

(Montgomery 1985, 1996, 1999), other numerical and conceptual groundwater flow models developed for the Coconino Plateau and adjacent areas (Bills et al. 2007; Kessler 2002; Wilson 2000), and investigations of springs that issue along the South Rim (Fitzgerald 1996; Goings 1985; Johnson and Sanderson 1968; Liebe 2003; Loughlin and Huntoon 1983; McGavock et al. 1968; Metzger 1961; Monroe et al. 2005; Rihs et al. 2004; Zukosky 1995). There are more deep groundwater wells with which to provide information on the Redwall-Muav aquifer system (henceforth referred to as the R-aquifer system or the regional aquifer system) south of Grand Canyon than to the north. However, important research has been conducted by Huntoon (1968, 1970, 1974, 1981, 1982, 1996, 2000), Woodward-Clyde Consultants (1985), Ross (2005), and Bills et al. (2010) in relation to groundwater circulation and selected large springs north of the Colorado River. Except for the Orphan Lode Mine, located at the South Rim of Grand Canyon directly north of Tusayan, and the Canyon Mine, located in the South Parcel, all of the information available for historic and current uranium mining practices in the region of the proposed withdrawal area comes from environmental assessments (EAs), mine plans, reclamation plans, personal communication with former and current mine employees, and other studies conducted for the mines in the North Parcel.

3.4.2 Hydrogeologic Conditions in the Study Area

This section characterizes the hydrogeologic components of the water resources system that may be affected by the proposed action or alternatives. Climatic conditions, which vary depending on land surface altitude, control the distribution of precipitation and evapotranspiration in the hydrogeologic framework. To a large extent, the hydrogeologic features of the region control the movement and fate of snowmelt, stormwater runoff, groundwater recharge, and groundwater in the underlying perched and regional aquifer systems. The lithology and structural deformation of the rock units in the study area are principal controls for movement and storage of groundwater. Human activities, such as groundwater withdrawal, diversion of discharge from springs, and development of the land surface, also affect the availability and quality of water.

The study area is located in the Plateau Uplands Hydrogeologic Province of Arizona, which is a high desert plateau region in which landforms are dominated by deeply incised canyons, high isolated mesas and buttes, and volcanic peaks (Cooley 1963; Montgomery and Harshbarger 1989). The land surface over much of the study area consists of fractured, jointed limestone with some permeable volcanic rocks, which provide for rapid infiltration of precipitation and result in meager surface water runoff (Huntoon 2000; Montgomery and Harshbarger 1989). As a result, the study area has a small number of perennial streams and rivers. The Coconino, Kaibab, and Kanab plateaus and the Marble Platform (see Figure 3.4-2) are characterized by very thick, nearly flat-lying sedimentary strata. The Colorado River is the principal drain for the groundwater systems in the plateaus, although groundwater in the north part of the North Parcel is believed to move north toward deep groundwater basins in Utah.

Extensive exposure of aquifer units along deep canyons cutting the plateaus of the study area and the ability to observe groundwater discharge from the aquifers into the canyons, together with well records, provide a degree of information on regional hydrogeologic conditions not commonly available for most regions of the country. This information has led to cogent interpretations of the groundwater systems in the Grand Canyon region, such as those by Huntoon (2000). Nevertheless, because of the size of this remote region and the depth of the groundwater systems, there remains uncertainty regarding deep geological structures, groundwater flow paths, aquifer hydraulic properties, residence times of groundwater in aquifers, and other hydrogeologic features in many parts of the study area.

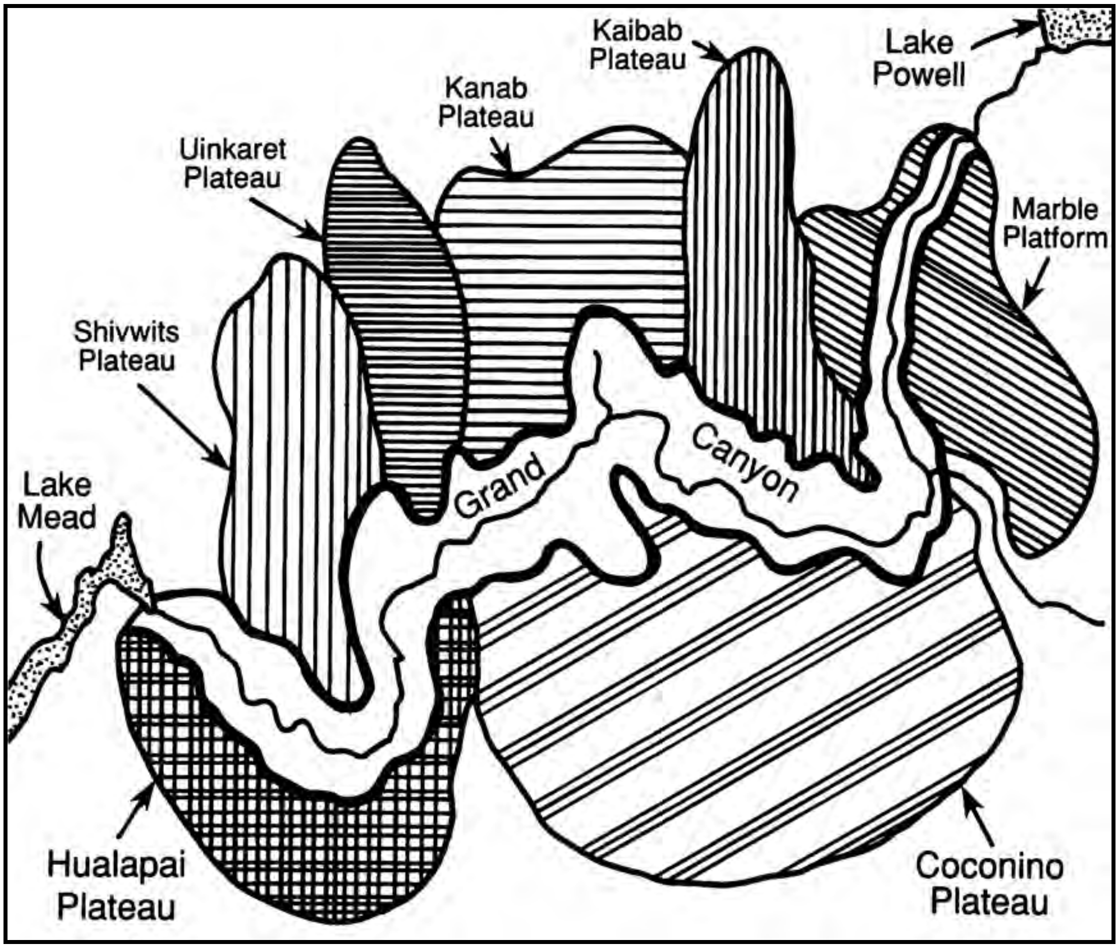


Figure 3.4-2. Generalized map showing major plateaus of the area surrounding Grand Canyon (from Beus and Morales 2003).

The most productive aquifer, the R-aquifer, is deep (generally more than 2,000 feet below land surface [bls]) and occurs in limestone and dolomite units that are gently folded and exhibit relatively shallow regional dips. Although the plateau region is often described as a "water-short area," deep groundwater is likely available over large areas. However, because of the great depth of the regional aquifer, costs for drilling, construction, and pump equipment are very high; the total cost can exceed $3 million for one well. Although groundwater yield from the R-aquifer is prolific where karst and other interconnected permeability features are abundant, there is a high degree of risk that wells not encountering these features may be dry or low yielding. There is also a high degree of risk that the water yielded by the well will be mineralized with high total dissolved solids (TDS) content and other constituents, especially in confined (artesian) parts of the regional aquifer (Huntoon 2000). Therefore, financial risk is high for R-aquifer well construction. These risk factors and a lack of understanding by many water developers of the groundwater systems, particularly regarding geological conditions that control locations of aquifer zones that could yield substantial volumes of groundwater to wells, have prevented more extensive development (Montgomery et al. 2000). Records indicate that no non-commercial or non-industrial entities have installed R-aquifer wells on any of the parcels, even though the R-aquifer is recognized as the most reliable source of groundwater. The only existing non-mine R-aquifer wells in the parcel areas are located at Tusayan on the South Parcel.

A summary of records for 1,333 wells in the study area is given in Appendix D. These records include data for location, well construction, water levels, and yield. It should be noted that the well inventory table was compiled from several different databases; thus, some duplication of wells may occur in Appendix D where sufficient data were not available to identify a single well from multiple similar records. The well inventory includes all well records in the ADWR and Arizona Oil and Gas Commission databases, including records for non-water production wells and records cancelled by ADWR for various reasons, such as records for wells that were abandoned or never drilled (ADWR 2005, 2009a; Arizona Oil and Gas Commission 2005). The well inventory was conducted for all wells within the three parcels and a 6-mile buffer perimeter surrounding each parcel, and for all wells 500 feet or deeper in the water resources study area. Of the 1,333 wells listed in Appendix D, those reported to be water wells that have not been cancelled by ADWR or abandoned include the following:

- **North Parcel.** Five R-aquifer wells (including the abandoned Hack Canyon Complex and Pigeon mine wells) and 105 perched aquifer wells in the North Parcel and 100 perched aquifer wells in the 6-mile buffer perimeter.
- **East Parcel.** Seven perched aquifer wells in the East Parcel and 26 perched aquifer wells in the 6-mile buffer perimeter.
- **South Parcel.** Four R-aquifer wells and 16 perched aquifer wells in the South Parcel, 19 perched aquifer wells in the 6-mile buffer perimeter, and four R-aquifer wells beyond 6 miles from the southern and western boundaries of the South Parcel.

Of particular interest in this analysis are the 13 wells constructed to yield groundwater from the R-aquifer within or in the vicinity of the parcels. Records for these regional groundwater wells are provided in Table 3.4-1.

Existing wells of record that are not reported to be abandoned or cancelled (not drilled) are shown on Figures 3.4-9, 3.4-11, 3.4-12, and 3.4-13. However, for the following reasons, the wells shown may not be an accurate representation of all water wells in each parcel:

1. Errors in well registration may have resulted in some records that do not clearly report status or well type (i.e., some wells may not actually be water wells, or may have never been drilled, or may have been abandoned).
2. Some “pre-code wells” (wells drilled prior to establishment of the Arizona Groundwater Code) may have never been registered and are not in the ADWR databases.
3. Some wells may be damaged or have malfunctioning pump equipment that cannot be removed, thereby rendering the wells unusable.
4. Some wells may be dry.

Geological logs for the supply/monitor wells constructed for four of the uranium mine sites in the North and South parcels provide data for rock units encountered at these mine sites. These geological logs are summarized in Table 3.4-2.

Conceptual geological sections shown in Figures 3.4-3 and 3.4-4 provide a regional perspective for subsurface conditions in the study area and vicinity for the following discussion. Figure 3.4-5 is a geological map with surficial geology, major structural features, and breccia pipe locations in the water resources study area. Geological sections, with localized stratigraphic relations and major structural features for the study area, are shown in Figure 3.4-6a (from Brown and Billingsley 2010). Map locations for the geological sections in Figure 3.4-6a are shown in Figure 3.4-5.

The principal geological units that crop out and/or occur in the subsurface in the study area, in descending order, are described in the following sections and are organized by age and stratigraphic position in

Figure 3.4-6b. Where present, each of these units plays an important role in the movement and/or storage of groundwater in the study area. Detailed descriptions of the individual rock formations and aquifers in the Grand Canyon region are given in Beus and Morales (2003), Bills et al. (2007), Bills et al. (2010), Bills et al. (2000), Harshbarger (1973a, 1973b, 1974, 1977), Harshbarger and Associates (Harshbarger) and John Carollo Engineers (1972), Harshbarger et al. (1957), McKee (1974, 1982), McKee and Resser (1945), McNair (1951), Metzger (1961), Montgomery (1985, 1993a, 1996, 1999), Montgomery and DeWitt (1975), and Montgomery et al. (2000). Descriptions of the individual rock formations in the following sections are based on these sources and the experience of Montgomery, BLM, and USGS personnel, and others, in the region.

Alluvial Deposits

The alluvial deposits are a heterogeneous mixture of unconsolidated to consolidated sediments ranging in grain size from silt and clay to boulders. The alluvial deposits are Quaternary and Tertiary in age and occur chiefly in valley floors and stream channels and along the margins of volcanic rocks. Where exposed in valley floors, the alluvial deposits commonly range in thickness from a feather edge to a few tens of feet. Thickness of older alluvial deposits may be more than 100 feet at the margins of volcanic rocks (Montgomery 1996).

Alluvial deposits that occur in the valley floors are permeable and transmit precipitation and stormwater runoff from the land surface to underlying formations. Where alluvial deposits overlie less permeable rocks, temporary perched groundwater zones may occur in the lower part of the alluvial deposits. Such perched groundwater zones are thin and discontinuous and are generally ephemeral; the stored water is gradually lost via evapotranspiration and slow downward seepage, especially during periods of precipitation deficit.

Volcanic Rocks

The volcanic rock sequence in the study area comprises lava-flow rocks, dikes, plugs, and pyroclastics, including volcanic ash and cinders that are Quaternary and Tertiary in age. Precambrian volcanic rocks occur at depth in the Grand Canyon but are not important for this investigation. The thickness of the volcanic rocks ranges from about 20 feet at the edge of some lava flows to more than 1,000 feet near the centers of past volcanic eruptions (Montgomery and Harshbarger 1989). Where present at land surface, cinders provide an excellent infiltration medium. As water infiltrates, the subsurface sequence of consolidated volcanic rocks commonly has small vertical permeability and retards the downward movement of water, except where extensively fractured. Thin, discontinuous, perched groundwater zones occur locally in the volcanic rocks and typically discharge at seeps and springs along the margins of volcanic outcrops. These perched groundwater zones have been penetrated by wells and yield small, often poorly reliable, quantities of water for domestic and stock use (Montgomery and Harshbarger 1989).

Glen Canyon Group

The Glen Canyon Group is Jurassic in age and, in the study area, consists of the following formations in descending order: Navajo Sandstone, Kayenta Formation, and Moenave Formation. This group forms the steep face of the Vermilion Cliffs, which occur a short distance north of the North and East parcels (see Figures 3.4-1, 3.4-4, and 3.4-5). The thickness of the Glen Canyon Group in the study area ranges from about 2,200 feet in the House Rock Valley area to about 2,500 feet in the Kanab Plateau area (Blakey 1989). Navajo Sandstone is a cross-bedded eolian sandstone (Blakey 1989), which, throughout most of the region, has a very consistent lithology composed of medium- to fine-grained, subrounded quartz grains weakly bonded by calcareous cement (Harshbarger et al. 1957). The Navajo Sandstone is partly

Table 3.4-1. Summary of Records for Wells Completed in the Regional Aquifer within and adjacent to the Proposed Withdrawal Area

Site	Well Location	Record Source*	Database Identifier	Date Completed	Total Depth Drilled (feet bls)	Casing Diameter (inches)	Casing Depth (feet)	Casing Cemented	Casing Perforated Interval (feet)	Land Surface Altitude (feet amsl)	Groundwater Level Depth (feet)	Groundwater Level Date Measured	Groundwater Level Altitude (feet amsl)	Design Pumping Capacity (gpm)	Reported Well Yield (gpm)	Comments
Tusayan	A(30-02) 24caa	ADWR GWSI	523284 355811112074501	05/01/1989	3,108	13 8	0–35 0–2,330	Yes	none	6,575	2,420	05/16/1989	4,155	80	NR	Canyon Squire Inn; cement grout from 0–35 feet; 150 sacks of grout from 1,500–2,330 feet; South Parcel.
Tusayan	A(30-02) 24bac	ADWR	542928	05/03/1994	3,000	13 8	0–25 0–2,306	Yes	none	6,600	2,400 2,850	1994 10/25/1995	4,200	85	65	Quality Inn; South Parcel.
Tusayan	A(30-02) 24acd	ADWR†	560179	06/30/1997	3,120	8 7	0–2,440 0–3,100	Yes	2,400–3,100	6,600	2,400	1997	4,200	100	25	Behind McDonald's; South Parcel.
Valle	A(26-02) 11ddb	ADWR GWSI	543573 353843112083301	06/15/1994	3,450	13 8	0–25 0–2,602	Yes	none	6,000	2,550	1994	3,450	85	89	South of South Parcel.
Valle	A(26-02) 01cdd	ADWR	545765	12/28/1994	3,200	13 8	0–23 0–2,630	Yes	none	6,050	2,500	1994	3,550	41	41	South of South Parcel.
Hack Canyon Mine Complex‡	B(37-05) 26abb	ADWR	640855	06/17/1980	1,760	6	40	N/A	none	4,275	1,096	06/17/1980	3,179	5	5	Filled with mud from 1,475–1,760 feet; filled with concrete from 0–1,500 feet on 01/29/1988; filled with limestone from 1,330–1,760 feet; North Parcel.
Hermit Mine	B(38-04) 17cca	ADWR GWSI	518877 364123112450501	01/12/1988	3,030	10 8⅝ 5½	0–20 0–970 0–1,796	Yes	none	4,886	1,513	01/12/1988	3,373	15	15	Presently capped with no pump; unused; North Parcel.
Kanab North Mine	B(38-03) 17cca	ADWR	509198	11/05/1984	2,700	7⅝	860	Yes	none	5,043	1,470	11/05/1984	3,573	10	10	Well collapsed up to 2,460 feet; North Parcel.
Pigeon Mine‡	B(38-02) 05abb	ADWR	503711	09/03/1982	2,350	6	–	–	none	5,406	1,736	09/03/1982	3,670	10	10	Land surface altitude estimated from USGS National Elevation data (USGS 2010c); abandoned by filling with cement; North Parcel.
Pinenut Mine	B(36-04) 21cbc	ADWR	513394	09/26/1986	3,200	8⅝ 6⅝	0–900 0–2,524	Yes	none	5,338	2,494	09/26/1986	2,844	11	11	North Parcel.
Bar Four	B(32-04) 24cd	Reclamation	N/A	12/00/1996	3,115	5½	3,107	–	2,550–3,107	5,680	2,370	1996	3,310	NR	50	Havasupai Reservation; ADWR permit not required; west of South Parcel.
Quivero‡	A(25-02) 27abb	USGS ADWR GWSI	N/A 601192 353134112094901	12/01/1969	3,685	7	3,670	–	2,880–3,670	6,165	2,838	12/00/1969	>3,327	NR	28	Poor water quality; yields from formations deeper than Redwall-Muav aquifer; south of South Parcel.
Canyon Mine	A(29-03) 20bcd	Montgomery ADWR	N/A 515772	12/02/1986	3,086	8⅝ 5½	0–2,281 2,116–3,086	Yes	2,584–2,964	6,507	2,536	07/29/1993	3,971	5 40	5 40	South Parcel.

Notes:

– = Data not available; N/A = Not applicable; NR = Not reported.

* Record sources:

GWSI = ADWR Groundwater Site Inventory

Reclamation = U.S. Bureau of Reclamation

† Manera Inc. provided data for reported yield.

‡ Well is abandoned.

Table 3.4-2. Geological Units Penetrated at Wells for Selected Breccia Pipe Uranium Mine Sites

Geological Unit	Pinenut Depth Interval (feet bls)	Hermit Depth Interval (feet bls)	Kanab North Depth Interval (feet bls)	Canyon Depth Interval (feet bls)	Pinenut Thickness (feet)	Hermit Thickness (feet)	Kanab North Thickness (feet)	Canyon Thickness (feet)
Moenkopi Formation	–	0–168	0–31	0–10	–	168	31	10
Kaibab Formation	0–442	168–550	31–585	10–340	442	382	554	330
Toroweap Formation	442–775	550–899	585–801	340–550	333	349	216	210
Coconino Sandstone	775–877	899–930	801–817	550–1,125	102	31	16	575
Hermit Formation	877–1,579	930–1,678	817–1,467	1,125–1,237	702	748	650	112
Supai Group	1,579–2,547	1,678–2,850	1,467–2,460*	1,237–2,242	968	1,172	993*	1,005
Surprise Canyon Formation	–	2,850–3,010	–	–	–	160	–	–
Redwall Limestone	2,547–3,200	3,010–3,030	2,460–2,700*	2,242–2,670	> 653	> 20	> 240*	428
Temple Butte Formation	–	–	–	2,670–2,780	–	–	–	110
Muav Limestone	–	–	–	2,780–2,980	–	–	–	200
Bright Angel Shale	–	–	–	2,980–3,086	–	–	–	> 106
Total Depth Drilled	**3,200**	**3,030**	**2,700**	**3,086**	**3,200**	**3,030**	**2,700**	**3,086**

Note:

– = data not available because not reported.

* = estimated.

> = greater than; base of unit not penetrated.

saturated to completely saturated and is a significant source of groundwater supply north of the study area at Fredonia and the Kaibab Paiute Indian Reservation and is a major source of groundwater to the north in Utah (Cordova 1981) and to the east on the Navajo and Hopi Indian reservations. The lower portion of the Glen Canyon Group in the study area consists of the Kayenta and Moenave formations, which comprise several hundred feet of interbedded and inter-tonguing sandstones and siltstones (Blakey 1989); the fine-grained beds may function as confining layers that retard the downward movement of groundwater.

Chinle Formation

The Chinle Formation is Triassic in age and consists of lacustrine rocks and sediments containing clay, heterogeneous clastic rocks, and minor carbonate rocks (Blakey 1989). The Chinle Formation and its basal conglomerate, the Shinarump Member, were eroded from most of the study area but crop out at the base of the Vermilion Cliffs north of the North and East parcels, and near the top of Red Butte in the South Parcel (see Figures 3.4-1, 3.4-4, and 3.4-5). Thickness of the Chinle Formation in the study area ranges from about 500 feet in the Kanab Plateau area to about 1,000 feet in the House Rock Valley area (Blakey 1989). This predominantly very fine-grained unit is an excellent confining layer that retards the downward movement of groundwater where present in the study area (Harshbarger et al. 1957; Repenning et al. 1969). The Shinarump Member, where present in the North Parcel area, is a discontinuous, perched water-bearing zone that is locally a source of groundwater for springs and wells (Levings and Farrar 1979; Truini et al. 2004).

Moenkopi Formation

The Moenkopi Formation consists chiefly of thin-bedded, fine-grained, red sandstone, siltstone, mudstone, and gypsum and is Triassic in age (Blakey 1989). Although the Moenkopi Formation was completely eroded from large parts of the study area, scattered and discontinuous outcrops of the formation occur on the Shivwits, Uinkaret, Hualapai, and Coconino plateaus (see Figures 3.4-3, 3.4-4, 3.4-5, and 3.4-6a [sections B-B', D-D', and E-E']). These outcrops are generally less than 100 feet thick and typically occur where the formation is capped by erosion-resistant volcanic rocks or where remnant Moenkopi strata fill structural depressions, such as at breccia pipes. Larger, thicker outcrops of the Moenkopi Formation are exposed along the northern part of the study area, in the upper part of the Kanab Creek drainage area of the North Parcel, and in the East Parcel area (see Figure 3.4-3, 3.4-4, and 3.4-5). The thickness of the unit ranges from a few hundred feet in House Rock Valley to more than 1,000 feet near Fredonia, Arizona (Blakey 1989).

The fine grain size and poor sorting of the Moenkopi Formation strata cause the unit to function as a basal confining layer that retards the downward movement of percolating groundwater from overlying formations, except where the unit is extensively fractured (Cosner 1962). Sandstones in the Moenkopi Formation can be water bearing locally in the northern part of the North Parcel, where they yield groundwater to a few springs and low-capacity wells.

Kaibab Formation

The Kaibab Formation consists chiefly of thick- to thin-bedded, jointed, cherty, and sandy dolomitic limestone (McKee 1974), but it also contains dolostone, sandstone, evaporites, and redbeds (Hopkins 1990). The formation is Permian in age, crops out over large parts of the North, East, and South parcels, and forms the rim rock of the Grand Canyon at most locations (see Figures 3.4-3, 3.4-4, 3.4-5, and 3.4-6). Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Kaibab Formation ranges in thickness from about 300 to 450 feet. Thickness of the formation is reported to be more than 500 feet west of Kanab Creek and northwest of the Colorado River (Hopkins 1990) (see Table 3.4-2 for thickness of the Kaibab Formation reported in deep mine wells).

The Kaibab Formation is brittle and extensively fractured in areas where geological structural deformation has occurred. The erosion resistant dolomites that cap most of the plateaus in the eastern Grand Canyon region are permeable as a result of open vertical joints and epikarst localized on joints and partings along bedding planes (Huntoon 2000). Water circulation through these joints and fractures has enlarged the openings by dissolution and has created extensive systems of caves and caverns (Montgomery and Harshbarger 1989; Huntoon 2000). Cave passages in the Kaibab Formation have been observed at many locations in northern Arizona, including Wupatki National Monument (Cosner 1962) north of Flagstaff, Babbitt Ranch (Harshbarger 1973a) southwest of Tusayan, and the Grand Canyon. Where the Kaibab Formation is exposed at land surface, precipitation and runoff infiltrate readily downward via the fractures and solution openings, making the unit an important recharge medium. Many flash floods sink directly into "swallow holes" along fault zones in the Kaibab Formation (Huntoon 2000). However, because of high evapotranspiration, recharge is a small fraction of precipitation. In most of the study area, the Kaibab Formation is above the regional groundwater table; however, well data for the upper part of the Kanab Creek drainage area suggest that, although it may be perched, a viable water-producing aquifer occurs in the Kaibab Formation in that area. The unit is reported to yield small quantities of perched groundwater to a few wells in the Coconino Plateau and regional groundwater to wells near Cameron, Arizona (McGavock et al. 1968), located about 40 miles east of Tusayan (see Figure 3.4-5). Similarly, three water wells near Fredonia, Arizona, have reported pump capacities of between 50 and 400 gpm and are likely completed in the Kaibab and/or Toroweap formations where these units represent a viable aquifer.

Toroweap Formation

The Toroweap Formation is Permian in age and, in the study area, consists of an upper evaporite and red sandstone and shale member (Woods Ranch Member), a middle massive limestone member (Brady Canyon Member), and a lower fine-grained sandstone and evaporite member (Seligman Member) (McKee 1974). Because of the variability in composition, the topographic expression of the Toroweap ranges from a weak slope-former to a cliff-former. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Toroweap Formation ranges in thickness from about 100 to 300 feet. The cementation of the sandstone in the upper and lower members of the Toroweap Formation, which were deposited in a marine environment, is weaker than cementation in the eolian Coconino Sandstone, described in the following section.

Fine-grained strata in the upper and lower members of the formation function as basal confining layers for the local accumulation of thin, discontinuous, perched groundwater zones in overlying sandstone strata. The middle massive limestone member of the Toroweap Formation is brittle and extensively fractured. Fractures in the limestone member have commonly been enlarged by solution activity and solution openings are abundant in this member. Gypsum karst is developed at some locations where solution features are prevalent and the Toroweap Formation is the dominant geological unit exposed at land surface (Huntoon 2000). Groundwater percolates downward readily via fractures and solution openings in the limestone member. The Toroweap Formation is considered to be a minor aquifer in parts of the Coconino and Kanab plateaus and yields small quantities of groundwater to wells from thin, discontinuous perched groundwater zones in the upper and lower members. The Toroweap Formation is reported by McGavock et al. (1968) to yield less than 5 gallons per minute (gpm) from a few wells in the Grand Canyon Village area. Well data for the upper part of the Kanab Creek drainage area suggest that although it may be perched, the Toroweap Formation is a viable water-producing aquifer in that area. For example, the Pah Tempe Spring system, located near Hurricane, Utah, discharges more than 4,100 gpm from the Toroweap Formation (Dutson 2005).

Coconino Sandstone

The Coconino Sandstone is Permian in age and is a very fine- to fine-grained, cross-bedded eolian sandstone composed chiefly of subangular to well-rounded, frosted quartz grains (Metzger 1961). The Coconino Sandstone is commonly a cliff-former in outcrop, is a well-lithified and brittle rock unit, and is extensively fractured near faults and folds. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Coconino Sandstone ranges in thickness from about 500 to 600 feet. Billingsley and Ellis (1984) report that the Coconino Sandstone does not crop out between the Toroweap and Hermit formations along the Kanab Creek Wilderness Area of Snake Gulch, about 18 miles north from the Grand Canyon (see Figure 3.4-1). Inspection of Table 3.4-2 indicates that thicknesses of only 16 and 31 feet of the Coconino Sandstone were penetrated by the supply/monitor wells at the Hermit and Kanab North mine sites, respectively.

The Coconino Sandstone, together with the Toroweap and Kaibab formations, is part of the principal aquifer (also known as the C-aquifer) for water wells in the San Francisco Plateau of northern Arizona (east and southeast of the Coconino Plateau), where the regional groundwater table occurs above the base of the formation. Municipal water supply wells for the city of Flagstaff obtain groundwater from the Coconino Sandstone, and hydraulic parameters have been computed from results of pumping tests (Montgomery and DeWitt 1975). At the Woody Mountain well field near Flagstaff, the permeability of the formation is great as a result of the occurrence of abundant fractures, and pumping rates from individual wells are as great as 1,000 gpm. Where the Coconino Sandstone is not abundantly fractured near Flagstaff, permeability is small, and pumping rates from individual wells are commonly less than 100 gpm.

In the study area, west of the extensive Mesa Butte Fault Zone on the Coconino Plateau, the regional groundwater table (for an unconfined aquifer) or potentiometric surface (level to which the groundwater would rise if not trapped in a confined aquifer) occurs below the base of the Coconino Sandstone and the formation does not contain groundwater at most locations (Bills et al. 2007) (see Figure 3.4-5 for location of Mesa Butte Fault). This condition is observed in the proposed withdrawal area and along the north and south walls of the Grand Canyon. Where favorable structural conditions occur and where mudstone strata in the underlying Hermit Formation provide a basal confining layer that retards the downward movement of groundwater, thin, discontinuous perched groundwater zones may occur in the lower part of the Coconino Sandstone and may supply small quantities of groundwater to springs and wells for domestic and stock use. At mineralized breccia pipes, a sulfide zone or "pyrite cap" often occurs in the base of the Coconino Sandstone or Toroweap Formation at the top of the ore deposit and causes any perched groundwater in the base of the unit to be highly mineralized and of poor quality (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Based on interpretation of regional water quality data, Bills et al. (2010) concluded that elevated concentrations of arsenic, iron, lead, manganese, sulfate, radium, and uranium may be the result of recharge that contains dissolved gypsum derived from overlying formations (such as the Moenkopi and/or Chinle formations) or from natural contact with sulfide-rich mineralization.

Hermit Formation

The Hermit Formation is Permian in age and consists chiefly of interbedded red silty sandstone and sandy mudstone (Blakey 2003). Where the Hermit Formation crops out, it forms a slope between the overlying cliff-forming Coconino Sandstone and the underlying ledge- and slope-forming Supai Group. The Hermit Formation ranges in thickness from about 100 feet in the eastern part of the Grand Canyon to more than 900 feet at the Toroweap Valley and Shivwits Plateau areas (McNair 1951). The formation thickens to the west (Blakey and Knapp 1989). At Snake Gulch, thickness of the Hermit Formation is about 575 feet (Billingsley and Ellis 1984). Because of its fine-grained lithology, the Hermit Formation generally retards the downward movement of groundwater and is considered to be an important basal confining layer for overlying thin, discontinuous perched groundwater zones in the study area.

Supai Group

The Supai Group in the study area is Permian and Pennsylvanian in age and is composed of the following four formations, in descending order: Esplanade Sandstone, Wescogame Formation, Manakacha Formation, and Watahomigi Formation (McKee 1982). The Supai Group consists of alternating siltstone and fine-grained sandstone units, with some limestone beds (Metzger 1961). Where the Supai Group crops out in the Grand Canyon, it is a ledge- and slope-forming unit. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Supai Group ranges in thickness from about 900 to 1,000 feet. The siltstone units are red and occur in flat, lenticular beds. The sandstone units are commonly light brown but in many places are stained red by the overlying siltstone. Because the Supai Group is composed chiefly of siltstone and fine-grained sandstone, groundwater does not move readily through the fine-grained, unfractured rock matrix, although some downward movement of groundwater does occur (Metzger 1961). The upper part of the Supai contains sandstone units that yield small quantities of water from local thin, discontinuous, perched groundwater zones to seeps in the Grand Canyon. The Supai Group is reported to yield small quantities of groundwater to wells in the study area. Fracture permeability along widely spaced fault zones allows water to move downward (Huntoon 2000). However, the Supai functions chiefly as a confining layer, retarding downward groundwater movement to the more permeable underlying formations.

Surprise Canyon Formation

The Surprise Canyon Formation is composed of isolated, lenticular deposits of clastic and carbonate rocks that fill erosional valleys, caves, and other local karst features in the top of the Redwall Limestone (Beus 1990a). The Surprise Canyon Formation is Mississippian in age and can be divided into three units: 1) an upper unit that consists chiefly of marine siltstone and silty, sandy, or algal limestone; 2) a middle unit that consists of marine skeletal limestone; and 3) a basal unit that consists of terrestrial conglomerate and sandstone. The Surprise Canyon Formation is probably the least visible rock unit in the Grand Canyon as a result of the discontinuous nature and extreme remoteness of outcrops; the formation was not identified formally until 1985 (Billingsley and Beus 1985).

Redwall Limestone, Temple Butte Formation, and Muav Limestone

The Redwall Limestone, Temple Butte Formation, and Muav Limestone form a sequence of carbonate rocks comprise the Redwall-Muav aquifer system (henceforth referred to as the R-aquifer system or the regional aquifer system). The Redwall Limestone is Mississippian in age and consists of thick-bedded, cliff-forming, microcrystalline, light to dark gray limestone and dolomite (Metzger 1961; Huntoon 2000). The most abundant rock-forming minerals in the R-aquifer are calcium and magnesium carbonates. The Redwall forms massive vertical cliffs that are 500 to 800 feet thick in the Grand Canyon; thickness increases to the west and to the east from the Grand Canyon Village area (Beus 1989). Where exposed, the Redwall Limestone is commonly stained red by iron oxide material washed down from red beds in the overlying Supai Group (Beus 1990a).

The Temple Butte Formation underlies the Redwall and consists chiefly of microcrystalline dolomite or sandy dolomite with minor beds of sandstone and limestone (Beus 1990b; Huntoon 2000). The Temple Butte is Devonian in age, crops out as thin ledges, and occurs in channels cut into the underlying Muav Limestone. Thickness of the formation ranges from about 100 feet in scattered channel-fill lenses to more than 450 feet west of the Grand Canyon; westward from Hermit Creek, the Temple Butte forms a continuous band of dolomite above local basal channel-fill deposits (Beus 1990b).

The Muav Limestone is Cambrian in age and consists chiefly of thin- to thick-bedded dolomitic and calcareous mudstone and packstone, with intraformational conglomerate (Middleton and Elliott 1990). The Muav forms resistant cliffs above the underlying Bright Angel Shale in the Grand Canyon. The contact with the underlying Bright Angel Shale is gradational and is characterized by complex inter-tonguing of the two formations. Bedding and formation thicknesses increase to the west. McKee and Resser (1945) reported that thickness of the Muav in the study area ranges from 136 feet at the confluence of the Little Colorado and Colorado rivers to 439 feet at Toroweap Valley in the central part of the Grand Canyon.

A sequence of undifferentiated Cambrian-age dolomites, with thicknesses as great as 426 feet in the western part of the Grand Canyon (Middleton and Elliot 2003), overlies the Muav Limestone and is part of the R-aquifer system.

In the study area, the Redwall-Temple Butte-Muav sequence of carbonate rocks (R-aquifer) lies below or partly below the regional groundwater table and constitutes the regional aquifer system. Huntoon (2000) reports that combined thickness of these rocks is 1,300 feet in eastern Grand Canyon, thickening to 2,500 feet in western Grand Canyon. In the Coconino Plateau, total thickness of the formations that constitute the R-aquifer at wells and at the South Rim of the Grand Canyon ranges from about 500 to 1,000 feet; the average thickness is about 750 feet. Results of pumping tests for well (A-29-3)20bcd, located at the Canyon Mine southeast of Tusayan, indicate that transmissivity of the R-aquifer in this relatively unfractured area is about 1,000 gallons per day per foot width of aquifer (gpd/foot) at a 1:1

hydraulic gradient (Montgomery 1993b). Although the permeability of unfractured rock in the R-aquifer is typically very small, in areas where the rocks are extensively fractured by large extensional faults and flexures, solution openings have developed that provide for the transmission of large quantities of groundwater. Extensive interconnected maze cave and cavern systems occur in the R-aquifer, particularly along large fault zones (Huntoon 1968, 1970, 1974, 1981, 1982, 2000; Montgomery and Harshbarger 1989). The term maze cave, used by Huntoon (2000), refers to intersecting, closely spaced dissolution cavities and caves. Progressive upward collapse from caves and caverns in the Redwall Limestone is thought to be the origin of the pipes that eventually were filled with breccia and mineralized with the ore that is the target of breccia pipe prospecting in northwestern Arizona (Huntoon 1996).

Bright Angel Shale and Tapeats Sandstone

Together with the overlying Muav Limestone, the Bright Angel Shale and Tapeats Sandstone form the Tonto Group, which is Cambrian in age. The Bright Angel Shale consists chiefly of mudstone and shale, with minor thicknesses of sandstone and limestone (Metzger 1961). As a result of inter-tonguing with the overlying Muav Limestone, the thickness of the Bright Angel Shale is variable. McKee and Resser (1945) reported that the thickness of the Bright Angel Shale is more than 450 feet in the western part of the Grand Canyon, 270 feet at Toroweap Valley in the central part of the Grand Canyon, and 325 feet along Bright Angel Creek. The Bright Angel Shale functions as an effective basal confining layer for the overlying R-aquifer, even where faulted, as a result of its ductility (Huntoon 2000). The Tapeats Sandstone consists of cross-bedded, poorly sorted, coarse sandstone and conglomerate. Metzger (1961) reports that thickness of the Tapeats Sandstone ranges from a feather edge to 300 feet; thickness typically ranges from 100 to 325 feet (Middleton and Elliot 1990). Only small quantities of groundwater issue from seeps in the Tapeats Sandstone because it is overlain by the fine-grained Bright Angel Shale. The Bright Angel Shale and the Tapeats Sandstone are not known to yield groundwater to wells in the vicinity of the proposed withdrawal area, except at exploration water well (A-25-2)27aba, which was constructed for Black Mesa Pipeline, Inc., about 18 miles north of Williams, Arizona. Water quality and yield from this well are considered poor; therefore, the well is not presently used. The discharge from springs in the Bright Angel Shale and Tapeats Sandstone is commonly saline and limited in quantity.

Precambrian Rocks

The occurrence of sedimentary, metamorphic, and igneous rocks of Precambrian age below the Tapeats Sandstone in the study area is indicated from outcrops in the Grand Canyon and from analysis of deep oil test boreholes in the Flagstaff region. The permeability and porosity of the Precambrian rocks underlying the Grand Canyon region are generally very small, except where open fractures may occur along fault zones, and these rocks are expected to function as the basal confining layer to the overlying rock sequence.

3.4.3 Structural Features

The principal structural features in the study area are a series of north- to northeasterly trending fault zones as well as northerly trending folds and associated faults (see Figure 3.4-5). Many more faults and folds occur in the study area than can be shown with the low resolution of Figure 3.4-5. The major north- to northeasterly trending fault zones are the Bright Angel, Redlands, Red Horse, Vishnu, Hurricane, Sevier, Toroweap, Fence, Eminence, and Mesa Butte faults and the West Kaibab (including the Muav and Sinyala faults) and Cataract fault zones (some not shown in Figure 3.4-5). The major northerly trending folds and associated faults include the Supai, East Kaibab, and Echo Cliffs monoclines (not all shown in Figure 3.4-5). Where these geological structural systems are vertically continuous, enhanced by solution processes, and intersect the Grand Canyon, large springs discharge into the Canyon and its tributaries.

When groundwater moves along fractures in carbonate rocks, such as in the R-aquifer, the fractures are often widened by dissolution of soluble carbonate minerals. These preferential pathways are referred to herein as solution-enhanced permeability features or solution features; they range in size from small, interconnected fractures to large, interconnected cavern systems. Solution features preferentially develop along extensional fractures, faults, and folds that are generally aligned with the groundwater hydraulic gradient between points of groundwater recharge and points of discharge.

Permeability of the Kaibab Formation has been greatly increased in some areas by the presence of solution-enhanced fracture openings and joints. Because the Kaibab Formation comprises plateau surfaces over much of the area, karst topography is prevalent. For example, the Markham Dam fracture zone is an area of intense structural deformation along Cataract Creek, where oblique sets of extensional faults in the Kaibab Formation are readily visible at land surface and can be identified by the surface water drainage patterns, which are caused by preferential erosion along the fractured rocks of the fault traces (Montgomery 1996). Similarly, the Kaibab Plateau is broken by intersecting sets of well-developed fault zones and master joints in the Kaibab Formation that provide high capacity for infiltration of surface water flow (Huntoon 1974, 2000). The presence of karst in the parcels results in subterranean drainage, which together with low precipitation and high evapotranspiration contributes to the near absence of perennial flowing surface streams, except in the upper reach of Kanab Creek at Clearwater Spring, short reaches of Kanab Creek below Hack Canyon, and at a number of short, spring-fed perennial reaches of Kanab Creek tributary canyons.

The rocks underlying the Coconino Plateau (South Parcel) are folded into a gentle northwest-plunging syncline, referred to as the Cataract Syncline. The regional dip for the northern limb of the Cataract Syncline south from the Grand Canyon ranges from ½ to 1½ degrees to the southwest (Huntoon et al. 1986). This bedding dip controls the direction of groundwater movement away from the Grand Canyon in areas where faults are few or hydraulically isolated (see Figure 3.4-3). In areas where faults and cave systems occur, groundwater may be collected and conveyed toward or away from the Canyon, depending on the direction of hydraulic gradient.

The Kaibab Plateau is located on a north-south trending, doubly plunging anticlinal fold (Huntoon 2000). The rock units underlying the Kaibab Plateau (between the North and East parcels) are higher than correlative rock units underlying the Kanab Plateau and Marble Platform as a result of movement and deformation along the West Kaibab Fault Zone (including the Muav and Sinyala faults) and the East Kaibab Monocline (see Figures 3.4-2, 3.4-5, and 3.4-6a [section C-C’]). The Kaibab Plateau also lies at a higher altitude than the Coconino Plateau to the south (see Figures 3.4-3 and 3.4-5) and receives a greater amount of precipitation and snowmelt than the other areas.

Near the South Rim of the Grand Canyon, the Eremita Monocline (west of Hermit Creek), the Grandview Monocline, and other monoclines cause beds to dip locally northward toward the Grand Canyon (Huntoon et al. 1986). The north-dipping beds and bedding offsets associated with the monoclines and faults near the South Rim result in local areas where recharge collects along fracture systems, moves northward along bedding planes, and discharges at small springs and seeps where faults and fracture systems intersect canyon walls. Recharge in these local drainage catchment basins along the Canyon rim is very important to the occurrence and sustainability of local water-bearing zones that support the discharge at many small springs and seeps (average generally less than about 50 gpm) and at a few moderate-sized springs (average about 50 gpm to several hundred gallons per minute) within the Grand Canyon or its tributary canyons. Because of the northward dip and small discharge, these springs and seeps are considered to be poorly connected or in some cases not connected hydraulically to the regional solution-enhanced circulation systems of the R-aquifer (Montgomery 1996, 1999). However, the results of isotope studies reported by Monroe et al. (2005) and Bills et al. (2007) suggest that the apparent residence time in the aquifer of the water discharged at the small R-aquifer springs along the South Rim ranges from “modern” to 3,400 years. These results suggest that a fraction of the water from several of the springs may have slowly percolated downward from land surface and/or flowed from more distant parts of the aquifer, possibly south of the R-aquifer divide of Bills et al. (2007). Modern residence times are defined as being less than 50 years by Monroe et al. (2005) and as being less than 250 years by Bills et al. (2007). For comparison, the largest residence time reported was 22,600 years for an R-aquifer well in the city of Williams, Arizona, located about 52 miles south of the South Rim (Bills et al. 2007). Residence time reported for the Canyon Mine well, about 9 miles south of the South Rim, was 10,600 years (Bills et al. 2007).

Fracture systems associated with major structural features provide preferential pathways for recharge, transmission, and discharge of groundwater in the R-aquifer (Huntoon 1974, 1982, 2000; Montgomery 1985, 1996). Recharge from precipitation and ephemeral stream flow infiltrates downward through fracture systems associated with major structural features. Most groundwater discharged from the R-aquifer issues from several large springs located near major structural features in the Grand Canyon and its tributary canyons, such as Havasu Springs, Blue Springs, Fence Fault Spring complex, and Tapeats/Thunder River Spring complex (Huntoon 1982, 2000; Montgomery 1985, 1996; Montgomery et al. 2000). Therefore, these large springs are considered to be well connected hydraulically to the regional circulation systems of the R-aquifer. Thunder River is tributary to Tapeats Creek.

3.4.4 Breccia Pipes and Uranium Mining Legacy

Bills et al. (2010) and Otton et al. (2010) provide a comprehensive study of 1980s legacy mining issues related to uranium mining in the Grand Canyon region. Breccia pipes have been defined in other sections of this EIS, and a comprehensive overview of the history of breccia pipe uranium mines and genesis of the pipes and ore bodies is given in Wenrich and Titley (2008). The presence of naturally occurring dissolved uranium is nearly ubiquitous in groundwater and spring-fed surface water in the study area. Other trace metals associated with ore deposits are also common in groundwater. An important source for these dissolved constituents appears to be the mineralized rock that occurs in breccia pipes. The highest-grade uranium deposits in the United States occur in solution-collapse breccia pipes in northwestern Arizona (Wenrich and Titley 2008).

Figure 3.4-5 shows the locations provided by the USGS (Brown and Billingsley 2010) for 207 breccia pipes exposed by erosion (shown as solid red circles) and for 759 collapse features (shown as solid black circles), which also may include breccia pipes, located some distance from the canyon rims. Figure 3.4-7 shows the stratigraphic relation of perched groundwater zones and the regional R-aquifer to mineralized breccia pipe deposits. Figure 3.4-8 is a conceptual diagram showing various types of solution-collapse features in northwestern Arizona. All of the breccia pipes are surrounded by zones of ring fractures that may or may not be interconnected and that, where open, can create secondary permeability in the rocks and expose ore bodies in contact with the fractures to groundwater from perched water-bearing zones. Where exposed to erosion or oxidation from groundwater or surface water contact, ore minerals in breccia pipes tend to dissolve away, leaving little economic mineral value. These conditions have been observed in many breccia pipes exposed in the walls of the Grand Canyon (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010a, 2010b). Conditions that prevent significant exposure are required to preserve economically viable breccia pipe uranium deposits.

The continuum of conditions at breccia pipe ore deposits in the study area may be divided into three broad categories. In the first category, where breccia pipes and especially their ore bodies have been exposed in canyon walls for a significant amount of time, the uranium ore has largely been removed prior to modern times by oxidized surface water and groundwater. Exposure of breccia pipes in canyon walls results in accelerated weathering and fracturing of the pipe, which provides significant routes of access for water to dissolve and leach minerals out of the ore body. This condition may also occur where breccia pipes are developed along open fracture or fault systems. In the second category, where breccia pipes or their ore bodies are not significantly exposed, far less contact with migrating water is possible; this condition results in slow and longer term release of uranium into the groundwater or surface water. In the third category, breccia pipes containing economically viable uranium ore that could be targeted for mining in the study area are generally characterized by well-cemented, very low permeability breccias and adjacent formation rocks, which do not permit the flow of groundwater through the tightly locked mineral deposits. This condition inhibits dissolution of mineral deposits associated with these economically viable breccia pipes into groundwater.

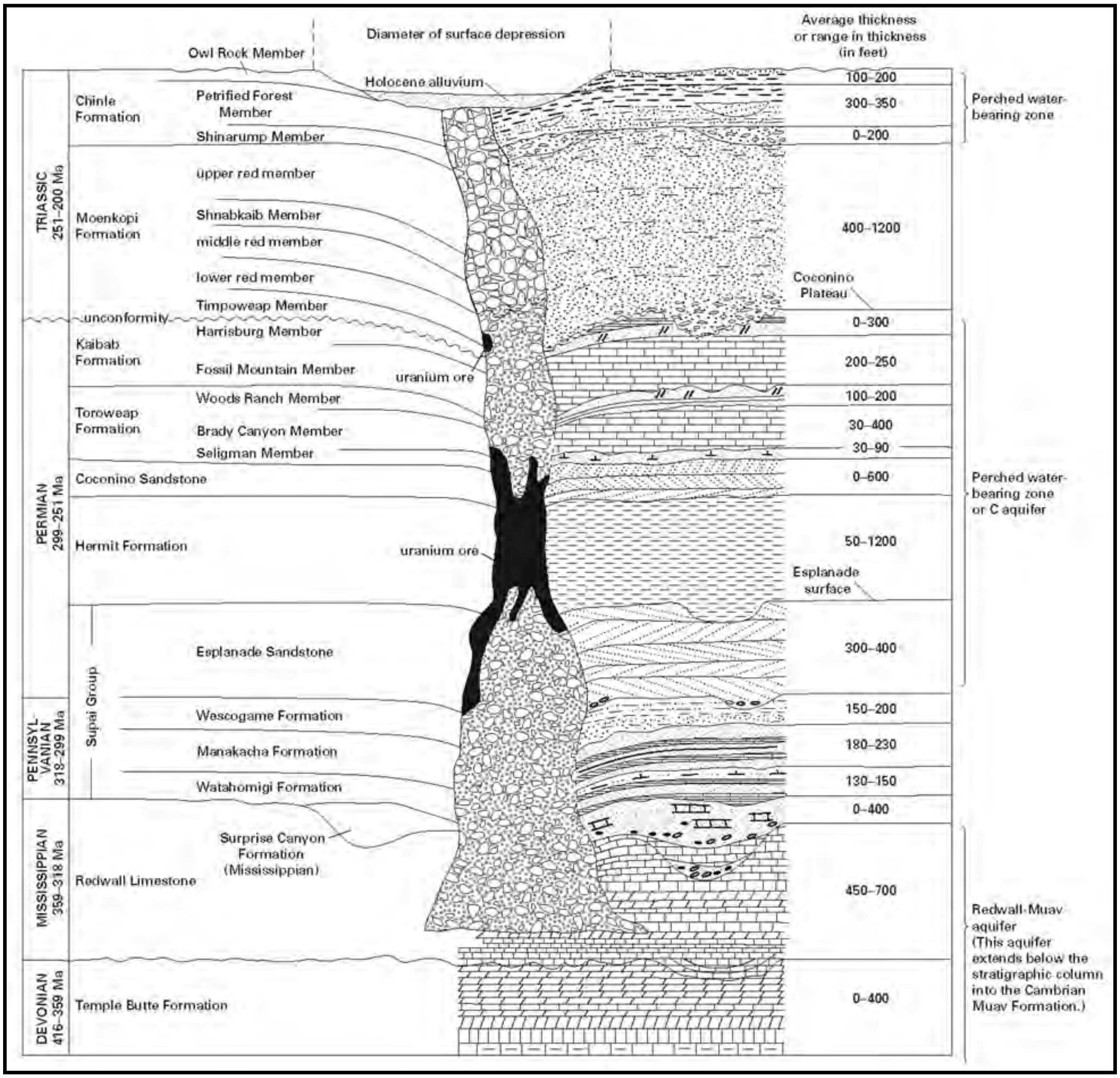
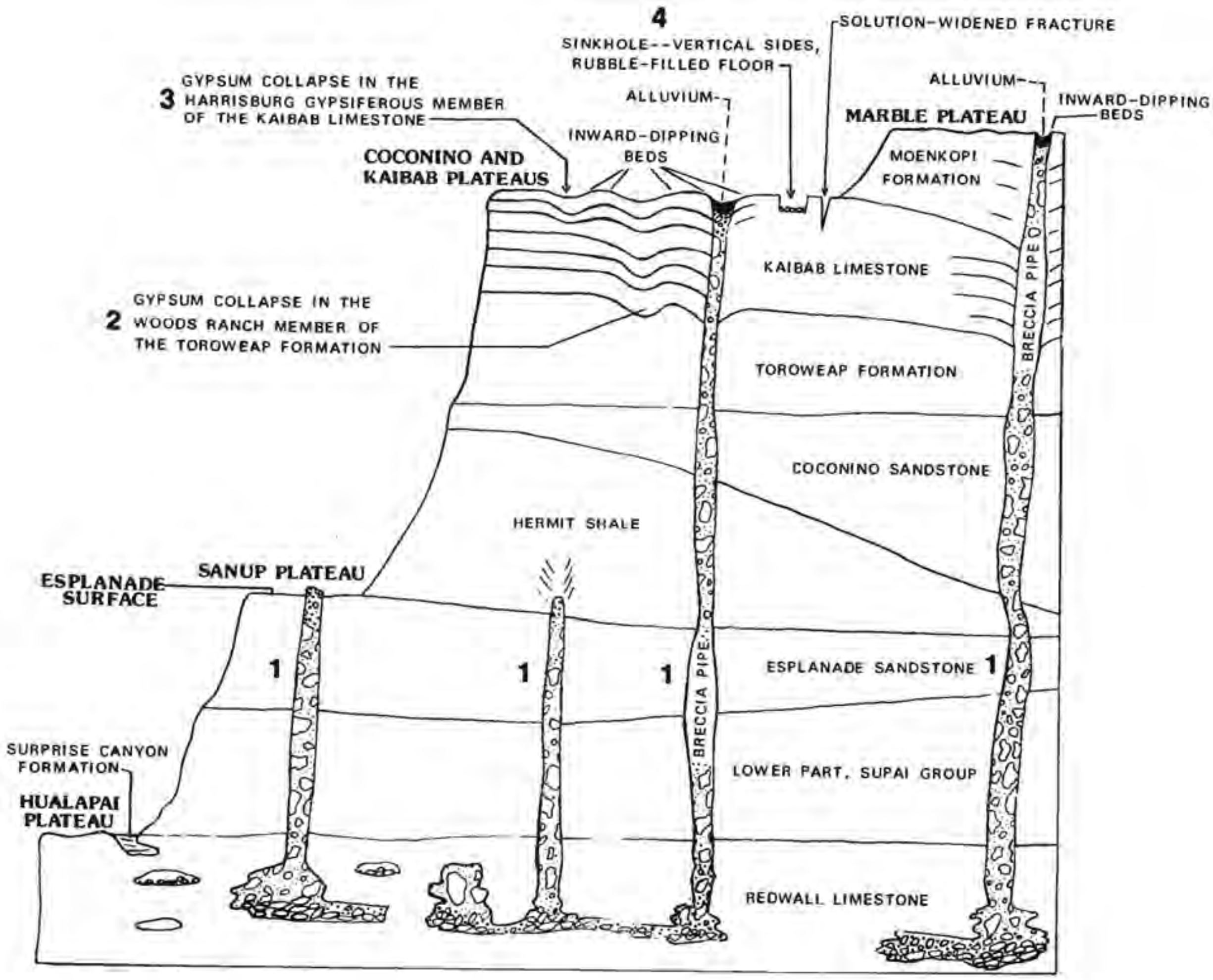


Figure 3.4-7. Stratigraphic relation of perched groundwater zones and regional aquifer to mineralized breccia pipe deposits in northern Arizona (from Bills et al. 2010 and modified from Van Gosen and Wenrich 1989).



(1) Breccia pipes that bottom in the Redwall Limestone, (2) Collapse due to dissolution of gypsum beds in the Woods Ranch Member of the Toroweap Formation, (3) Collapse due to dissolution of gypsum beds in the Harrisburg Gypsiferous Member of the Kaibab Limestone, and (4) Collapse (with vertical sides, as opposed to the gently-sloping sides of the other 3 collapse types) due to recent sinkholes in the limestone beds of the Kaibab Limestone.

Figure 3.4-8. Conceptual diagram showing various types of solution-collapse features found in northwestern Arizona (from Wenrich 1992).

Based on a review of ADEQ (1985, 1988a–c, 1995, 1999, 2009b–2009d), Energy Fuels Nuclear (1984, 1986, 1987, 1988a, 1988b, 1990a–c, 1995a, 1995b), BLM (2010b, 2010c), Dames and Moore (1985, 1987a, 1987b), JBR Environmental Consultants (2010), Montgomery (1993b), and Canonie Environmental Service Corporation (Canonie Environmental 1988, 1991), the modern (post-1980) breccia pipe uranium mine sites in the study area are generally of the third general type and are characterized by well-cemented, very low permeability breccias and adjacent formation rocks. Some ring fracture zones and the cemented breccia itself at these sites have locally contained some connate water (water trapped during formation of the geological feature), which drained away quickly when intercepted by mine openings; at many places, the ring fracture zones had been completely healed by carbonate or other mineralization and did not yield water (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010a).

In each case, these ore deposits are on the order of 1,000 feet or more above the R-aquifer system and are underlain by the poorly permeable breccias and siltstones/mudstones of the Hermit Formation and Supai Group. Therefore, conditions are not favorable for downward migration of leached minerals and constituents (such as uranium and arsenic) from the ore deposits to the R-aquifer (Dames and Moore 1987b).

Most of these sites have or had supply/monitor wells completed in the R-aquifer. Exploration drilling was also conducted at the sites. AAC R12-15-817 for exploration wells and AAC R12-15-816 for water wells require proper abandonment to prevent cross-contamination of different aquifers. ADWR records indicate that all but one of the water supply wells were constructed with cement seals and blank steel casing to prevent downward drainage of perched groundwater via the annular space between the blank casing and the borehole wall. Although not sealed during operation, the well for the Hack Canyon 1, 2, and 3 mines was abandoned by being filled with cement during reclamation. The Pigeon Mine well was also abandoned by being filled with cement (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). The wells are generally designed to yield groundwater from a significant thickness of the R-aquifer; therefore, groundwater samples obtained from the wells typically represent composite samples from the aquifer rather than the uppermost part of the saturated interval, which is required for many environmental monitor wells. Nevertheless, none of the studies conducted for water quality at these wells, one of which included periodic sampling data for up to 9 years after completion of mining activities (Hermit well), concluded that uranium mining activities have affected the R-aquifer. Based on their 2009 water quality sampling study, which included sampling of the Pinenut and Canyon mine wells, Bills et al. (2010) concluded that relations between the occurrence of dissolved uranium and 13 other trace elements and mining activities were few and inconclusive.

At the breccia pipe uranium mines in the study area, perched water-bearing zones, if present (typically above the Hermit Formation basal confining unit), are small, thin, and discontinuous. Water yield to mine openings from these perched zones typically decreases over the first few months to 2 years of mining, from several gallons per minute to no measurable flow (Canonie Environmental 1988). Because of the dipping of adjacent formation layers down toward the solution-collapse breccia pipe, any perched groundwater that is present is expected to drain inward to the mine openings, which function as local hydrologic sinks. This water collects in the sump at the bottom of the mine and is used for mine operations; the water remaining after the demands of mine operations are met is pumped to lined evaporation and containment impoundments at land surface (Energy Fuels Nuclear 1984, 1986, 1987, 1988a; JBR Environmental Consultants 2010; personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Therefore, movement of perched water away from the mine openings is not anticipated to occur during mine operations. JBR Environmental (2010) reported that estimated maximum average flow of perched groundwater into the mine openings for previous breccia pipe uranium mines in the North Parcel was about 0.9 gpm (0.119 acre-feet per month). There are no accounts of rapid recharge through underground mine workings at breccia pipe uranium deposits, even after significant stormwater runoff at land surface.

In accordance with applicable state and federal permits, the entrances to reclaimed mines have typically been sealed to prevent surface water from entering the mine openings (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Requirements for reclamation of the mines changed over time during the 1980s so that earlier mines, such as the Hack Canyon 1, 2, and 3 and Pigeon mines, were not specifically required to seal the perched groundwater zones. Perched groundwater drainage at these mines had either ceased or was very small (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). For example, inflow of perched groundwater to the Pigeon Mine ranged from a maximum rate of 7.1 gpm in May 1985 to a minimum rate of 0.08 gpm in June 1987 (Canonie Environmental 1988). However, reclamation for the Hermit Mine (the last mine closed) included sealing of the perched groundwater zones using bentonite and cement (personal communication, John Stubblefield, Denison 2010). Existing regulations allow for the requirement of sealing perched groundwater zones from new mines. To the extent that reclamation does achieve re-establishment of the perching layer, the perched water-bearing zones may be slowly replenished over time (possibly several years) until natural lateral movement in the perched system resumes. If the reclamation does not re-establish the perching layer, the area of the perched aquifer that is affected may continue to drain into the mine openings in response to seasonal recharge events. At existing mines operating under interim management (some for decades), conditions would be expected to be similar to mines in operation, and there is the potential for drainage and accumulation of perched groundwater, if present, in these mines as natural recharge occurs. Frequent and comprehensive monitoring, data collection, and reporting are necessary for pre-mining, mining, and post-mining periods to fully document subsurface conditions in mines and conditions at perched aquifer springs near mines.

It should be noted that environmental issues surrounding the Orphan Lode Mine (which is outside the proposed withdrawal area) are the result of the lack of mine reclamation, which has allowed surface water and/or perched groundwater to collect within one or more of the mine adits (Hom 1986) and drain through the mine openings to the R-aquifer. The location of this mine at the South Rim of Grand Canyon increases the risk of mine drainage via enhanced secondary permeability of faults or flexure fractures from “relaxation” due to lithostatic unloading near the Grand Canyon. Because significant volumes of ore-grade uranium deposits are present in the Orphan Lode Mine, this breccia pipe is of the second general type described previously in this section (some exposure of the pipe). This is confirmed from the cross-section of the mine provided in Hom (1986), which shows that only a very small portion of the breccia pipe/ore body was exposed to weathering prior to mining (Hom 1986:Figure 3). Drainage from the mine appears to have affected water quality in Horn Creek, which issues directly from the R-aquifer (Liebe 2003). See Section 3.4.7 and Appendix H for more information on impacts to groundwater from the Orphan Lode Mine. No pre-mining water quality data exist for Horn Creek to compare with post-mining data. Although the Orphan Lode Mine is a singularly poor example of post-mining practices, it does provide data with which to compare other mine sites. These comparisons are made in subsequent sections.

3.4.5 Surface Water Resources of the Study Area

Except for the main stem of the Colorado River, virtually all of the perennial surface water base flow in the study area, including the base flow for the Little Colorado River, is supported solely by flow from springs and seeps. Hydrologic features, including the location of selected wells, springs, and streams, for the study area are shown on Figure 3.4-9. Stream base flow is augmented by seasonal surface water runoff from precipitation and snowmelt. The source of water for the springs and seeps is groundwater in the R-aquifer and in small, discontinuous perched groundwater zones located above the regional aquifer. Groundwater recharge in the region occurs chiefly via infiltration of precipitation in areas of higher altitude, such as in the northeastern part of the Coconino Plateau (South Parcel area) and the Kaibab Plateau (between the North and East parcels). Recharge also occurs on the Hualapai Plateau (west of Cataract Creek), and at the Bill Williams Mountain and San Francisco Mountain complexes (south and southeast of the South Parcel, respectively), and via infiltration of surface water runoff in ephemeral stream channels located along major fault zones.

The Colorado River is the largest surface water body in the study area and is supported primarily by releases from Glen Canyon Dam, which is located about approximately 12 miles upstream of the East Parcel. For the period of record from 1971 to 2010, flow in the Colorado River at six gaging stations from Glen Canyon Dam to Diamond Creek, which is located downstream of the proposed withdrawal area, ranged from an average of 1.6 million gpm to 28.5 million gpm (USGS 2010d). The average flow during this period at the six stations was about 8.2 millon gpm.

Figure 3.4-10 shows mean annual precipitation from 1971 through 2000 in the study area. Most of the annual precipitation in Arizona occurs in late summer and mid-winter. Precipitation is provided by winter storms of the Pacific Ocean system and annual summer monsoon storm systems originating in the southern Pacific Ocean and the Gulf of Mexico (Jones 1993). Although the late summer monsoons provide intense rainstorms, these storms are of relatively short duration and are believed to provide limited groundwater recharge as a result of high rates of evapotranspiration during the summer. It is the longer duration of winter rain and snow and subsequent snowmelt that provide most of the groundwater recharge to the aquifers in the study area. Losses of rain and snow to evapotranspiration and sublimation are high in the region.

Figures 3.4-11, 3.4-12, and 3.4-13 show hydrologic features for the North, East, and South parcels, respectively. These figures include the same content as Figure 3.4-9 but are enlarged and centered on each respective parcel for clarity.

North Parcel

Kanab Creek is the only perennial surface water drainage in the North Parcel; all other drainages are ephemeral. Kanab Creek is perennial in its lower reach near the Colorado River, in a 2- to 3-mile-long reach associated with Clearwater Spring in the northern part of the North Parcel (see Figure 3.4-11), and in short reaches below a few small springs in its tributary canyons. Kanab Creek and its numerous ephemeral tributaries drain southward to the Colorado River. A north-south-trending surface water divide along Little Hurricane Ridge in the western part of the parcel separates the Kanab Creek surface water drainage basin from the Virgin River surface water drainage basin to the west (see Figure 3.4-11). Surface water on the North Parcel west of this divide flows northwestward into Clayhole Wash, which flows northwest toward the Virgin River in Utah. Several small springs and seeps issuing from perched water-bearing zones in the Moenkopi Formation, together with an extensive system of surface water retention dams constructed to reduce the salinity of runoff downstream (personal communication, Lorraine Christian, BLM 2010b), occur in the upper reach of Clayhole Wash in the western part of the North Parcel. A small area in the southwest corner of the North Parcel appears to overlap the surface water drainage areas for Tuckup Canyon and Toroweap Valley. Tuckup Canyon is tributary to the Colorado River, and Toroweap Valley is tributary to Toroweap Lake, which overflows to the Colorado River during periods of substantial surface water runoff.

East Parcel

The surface water drainage system of House Rock Valley is composed of several ephemeral washes that drain into North Rim canyons, including, from south to north, Bedrock (tributary to South Canyon), North, Rider, Soap Creek, and Badger canyons. These canyons are tributary to the Colorado River, which flows southward through Marble Canyon along the entire eastern boundary of the East Parcel (see Figure 3.4-12). There are no perennial surface water drainages in the East Parcel; however, some perched water-bearing zones discharge at a few small seeps and springs in these North Rim canyons, and several small to large R-aquifer springs discharge to the Colorado River along the west wall of Marble Canyon and into the bottom of the river channel downstream of its confluence with North Canyon. A small area (about 2 square miles) of the northernmost extent of the East Parcel lies within the surface water drainage area of the Paria River, which drains a short distance northward into Utah and then returns to Arizona and is tributary to the Colorado River near Lees Ferry.

South Parcel

No perennial surface water drainages occur in this parcel; however, numerous ephemeral washes occur across the area. Most of the parcel lies in the surface water drainage basin of Havasu and Cataract creeks, and the remainder is tributary to the Little Colorado River (see Figure 3.4-13). The perennial reach of Cataract Creek is called Havasu Creek, which begins at Havasu Springs. West of the surface water divide, ephemeral surface water on the South Parcel flows downgradient to the south, southwest, and west. During intense rainstorms, runoff from this part of the South Parcel may ultimately reach Havasu Creek, which is tributary to the Colorado River. However, permeable surficial deposits and sinkholes in the Kaibab Formation in ephemeral stream channels along major fracture zones, such as the Markham Dam fracture zone of Cataract Creek, have a high capacity to intercept surface water and convey it underground.

East of the surface water divide, ephemeral surface water on the South Parcel flows downgradient to the south and east (see Figure 3.4-13). During intense storms, runoff from this part of the South Parcel may ultimately reach the Little Colorado River, which is tributary to the Colorado River.

3.4.6 Groundwater Resources of the Study Area

Groundwater moves from areas of recharge to areas of discharge. In the study area, groundwater recharge occurs from infiltration of precipitation and ephemeral stream flow. The Grand Canyon and its larger tributary canyons function as groundwater drains. The principal aquifer in the study area is the regional R-aquifer system, which transmits and stores large quantities of groundwater. The R-aquifer includes the carbonate rocks of the Redwall Limestone, Muav Limestone, and Temple Butte Formation. Groundwater movement in this aquifer occurs chiefly via fracture zones and interconnected cave passages, which are most abundant where faults are associated with tensional tectonic stresses (regional geological movements within the earth that cause extensional stress [pulling apart] in rocks versus compressional stress [pushing together]). These features together comprise a complex groundwater system that supports springs having diverse water quality and discharge characteristics. Uncertainty regarding specific flow paths and hydrologic connections in these types of groundwater systems is greater than for other types of systems, such as alluvial basins.

The C-aquifer includes the Coconino Sandstone and overlying or underlying water-bearing strata, including, at places, the Toroweap Formation, Kaibab Formation, and upper part (Esplanade Sandstone) of the Supai Group (see Figure 3.4-7). Outside the study area, east of the Mesa Butte Fault Zone, the C-aquifer is the principal groundwater source for the city of Flagstaff water supply; however, it is a thin, discontinuous perched water-bearing unit in the proposed withdrawal area (west of the fault). Bills et al. (2007) and Bills et al. (2010) indicate that the saturated thickness in this aquifer decreases to the west between Flagstaff and the Mesa Butte Fault Zone and north of the Little Colorado River as a result of downward drainage of groundwater to deeper units. South from the Little Colorado River, Bills et al. (2007) indicate the Mesa Butte Fault Zone functions as a barrier to groundwater movement in the C-aquifer. The rock units that form the C-aquifer west of the Mesa Butte Fault Zone, together with other perched water-bearing systems in the proposed withdrawal area store and transmit small amounts of groundwater, and their discontinuous nature allows only local flow of perched groundwater.

Groundwater moves in sedimentary rocks by flowing through pore spaces between the particles that form the rock matrix, as well as through fracture openings in the rock. The property of rocks that relates to their ability to transmit water through intergranular porosity is known as primary permeability. Where particles are relatively large, as in the case of sandstone, intergranular pore spaces may also be relatively large, and groundwater may flow with moderate ease unless cementation is substantial. Primary permeability for sandstones is commonly fairly large unless the pore spaces have been filled with carbonate or silica cement; sandstones may constitute aquifers that are conducive for water supply. Where particles are exceedingly small, as for mudstone or shale strata, intergranular spaces are also exceedingly small, and resistance to groundwater flow is substantial. Therefore, mudstone and shale strata, such as the Hermit Formation and parts of the Supai Group and Moenkopi Formation, generally function as barriers to groundwater movement (Montgomery et al. 2000). Intergranular spaces in carbonate rocks, such as many limestones and dolomites, are also usually exceedingly small. Unless larger openings occur, such as those associated with fractures and cave passages, carbonate rocks such as the Redwall Limestone may also constitute barriers to groundwater movement (Montgomery et al. 2000).

Both the C- and R-aquifer systems consist of brittle rock strata (Montgomery et al. 2000). When tectonic activity occurs, such as movement on faults, both units accommodate the associated stress and strain by fracturing. Where fractures are abundant in brittle rocks, the fractures enhance permeability and provide preferential pathways for groundwater movement. This “secondary permeability” of sandstones in the C-aquifer and carbonate rocks in the R-aquifer is substantially improved where fractures are abundant and interconnected. Because shale and mudstone strata tend to be ductile rather than brittle, these strata often flex rather than fracture when subjected to tectonic stresses (Montgomery et al. 2000). Open fractures that do occur in these strata tend to become filled or “healed,” blocking off pathways for groundwater movement. Because of the ductile nature of shale and mudstone strata, such as in the Bright Angel Shale and Hermit Formation, it is likely that these strata will continue to act as barriers to retard groundwater movement, even where tectonic activity has occurred.

Where groundwater movement occurs chiefly via the preferential pathways provided by interconnected fractures and solution-enlarged features such as caves, there is little opportunity for the removal of some groundwater contaminants via slow filtering through the intergranular pore spaces of the rock units. Therefore, where the hydraulic gradient of the groundwater system is sufficiently large, rapid movement of contaminated groundwater over large distances can occur via the fracture and cave passage network. These conditions can occur in the R-aquifer but primarily occur in the Kaibab Plateau (Huntoon 2000). However, it should be emphasized that the long residence times estimated for groundwater in the R-aquifer (Bills et al. 2010; Monroe et al. 2005), outside the immediate vicinity of springs along canyon walls where hydraulic gradients tend to be steeper, indicate that the typical condition in the aquifer of the Havasu Springs groundwater sub-basin supports slow groundwater movement conducive to gradual mixing and dilution as fracture and cave systems interconnect along the pathway to points of discharge.

Recharge

Groundwater beneath the study area originates as recharge from infiltration of rainfall and snowmelt. Average precipitation measured at Grand Canyon Village, in the northern part of the Havasu Springs groundwater sub-basin, during the period from 1941 through 1970, was about 14.5 inches per year (Sellers and Hill 1974). Normal annual precipitation for 1961 through 1990 measured at Williams, in the southern part of the Coconino Plateau, was 21.17 inches (Owenby and Ezell 1992). Metzger (1961) estimated average annual recharge to the R-aquifer to be about 0.3 inch per year, which is about 2% of the average annual precipitation measured at Grand Canyon Village. Montgomery et al. (2000) estimated a recharge rate of about 4% of the average annual precipitation for the Coconino and San Francisco plateaus based on total groundwater discharge from the principal aquifers. Bills et al. (2007) estimated an average recharge rate of about 3.5% of the average annual precipitation for the Coconino Plateau and adjacent areas.

Rainstorm events are often sporadic and localized, resulting in amounts of short-term, local groundwater recharge that can vary substantially from long-term, regional average recharge estimates. The frequency and magnitude of these events for a specific area can range widely from year to year. Therefore, although long-term average recharge for an area may be small, amounts of local, rainstorm-based recharge may be relatively large.

Most of the precipitation is lost via evaporation, transpiration, and surface water runoff. The remaining fraction infiltrates chiefly through permeable surficial deposits, volcanic rocks, and fractures and solution openings in the Kaibab Formation. Many flash floods sink directly into “swallow holes” along fault zones in the Kaibab Formation (Huntoon 2000). Where open, extensive, interconnected vertical fractures and solution openings occur, recharge can be conveyed directly to the deep aquifer system. Groundwater travel time from land surface to the deep aquifers varies temporally and spatially owing to variations in precipitation, air temperature, properties and thickness of the root and soil zone, presence of faults and fractures, and hydrologic properties of the geological strata in the unsaturated zone (Flint et al. 2004).

Where fractures and solution openings are not extensive or well connected, infiltrated precipitation moves downward until it encounters a confining rock layer with sufficiently small permeability to impede vertical movement of the water. At these locations, a thin, saturated zone, referred to as a perched groundwater zone, may form above the confining layer, and lateral groundwater movement may occur. Because confining layers are not completely impermeable, part of the perched groundwater eventually seeps downward through the confining layer matrix. The remaining perched groundwater moves laterally until it 1) encounters the edge of the confining unit and moves downward; 2) encounters fractures or other openings that permit downward movement through the confining layer; 3) discharges along canyon walls as seeps, springs, or evapotranspiration; or 4) is withdrawn from the perched aquifer via active wells. These conditions limit the extent of the perched aquifers, which are typically small, thin, and discontinuous.

Groundwater Occurrence in Perched Aquifers

In areas where confining layers are laterally continuous, groundwater may be perched. In the proposed withdrawal area, these conditions occur most commonly in the Toroweap Formation, where groundwater is perched in sandstone units that overlie fine-grained confining strata, and at the base of the Coconino Sandstone (or base of the Toroweap Formation in the north area, where the Coconino is absent), where groundwater may be perched on fine-grained strata of the Hermit Formation. The Moenkopi and Kaibab formations can also contain perched water-bearing zones, especially in the northern part of the North Parcel. At these locations, the perched aquifers may yield small quantities of groundwater to wells for domestic and stock use and to springs. These perched reservoirs are commonly small, thin, and discontinuous, and generally depend on annual recharge to sustain yield to wells and springs (Bills et al. 2010; Montgomery et al. 2000). The perched aquifers overlie and have no direct hydraulic connection to the deep R-aquifer; therefore, any downward movement of perched groundwater is by gravity drainage.

Discharge from Perched Aquifer Springs

In the proposed withdrawal area, seeps and springs issue from fractures, bedding planes, or sandstone strata in perched aquifers in the Chinle, Moenkopi, Kaibab, and Toroweap formations, Coconino Sandstone, and Supai Group along the walls and channels of canyons or from outcrops on the plateaus. Available data for the North Parcel and the South Rim of Grand Canyon indicate that groundwater discharge from individual seeps and springs is small, and the chemical quality of groundwater discharged from perched aquifer systems ranges widely from location to location (Appendix G; see Figures 3.4-11 and 3.4-13) (Bills et al. 2007; Bills et al. 2010; Monroe et al. 2005; Montgomery 1996, 1999). Available data for the East Parcel indicate that discharge from individual seeps and springs is small (Appendices D and E; see Figure 3.4-12); no water quality data are available. Records indicate that only one seep (Miller Seep) occurs on the South Parcel and there are no data for discharge quantity or quality; however, a recent visit to the seep by Forest Service personnel indicated the spring was dry (personal communication, Liz Schuppert, Forest Service 2010).

Groundwater Occurrence and Movement in the R-Aquifer

The R-aquifer is the only aquifer of regional extent that is capable of consistently yielding large quantities of groundwater to wells and springs in the proposed withdrawal area. On the Colorado River, from about river mile (RM) 50, 11 miles upstream from the mouth of the Little Colorado River in east Grand Canyon, to about RM 142, about 1.5 miles upstream from the mouth of Kanab Creek, the base of the R-aquifer is exposed in outcrop above river level (see Figure 3.4-9). Saturated thickness in the aquifer decreases toward the Grand Canyon (Metzger 1961).

Groundwater enters the R-aquifer in the proposed withdrawal area chiefly by downward migration of precipitation and stormwater runoff via vertical fractures and solution-enhanced features in overlying strata. Groundwater also enters as underflow from those portions of the R-aquifer that are hydraulically upgradient from the proposed withdrawal area. After groundwater enters the saturated zone in the R-aquifer, it becomes part of groundwater in storage in the regional system. Lateral groundwater movement is believed to occur chiefly via fracture and solution openings that are concentrated along principal structural features (Huntoon 1982, 2000). Arterial groundwater migration pathways, with large storage capacity and transmissivity, are believed to have developed in response to dissolution in the direction of the hydraulic gradient toward the principal drains for the aquifer system, such as the Little Colorado River, Havasu Springs, Tapeats Creek, Thunder River, Bright Angel Creek, and the Fence Fault complex reach of Marble Canyon (including Vasey’s Paradise), and downgradient areas to the north in Utah. The majority of the discharge from the R-aquifer in the vicinity of Kanab Creek occurs at Tapeats Creek and Thunder River, which are associated with the West Kaibab Fault Zone (including the Muav and Sinyala faults).

Direction of groundwater movement developed by Bills et al. (2007) and Bills et al. (2010) for the R-aquifer in the study area is shown in Figure 3.4-14. Direction of groundwater movement developed by Huntoon (1974) for the Kaibab Plateau region is shown in Figure 3.4-15 and is shown to be focused along principal fault zones.

Basin-type karsts, such as those associated with the fully saturated artesian conditions in the R-aquifer of the Havasu Springs groundwater sub-basin, are characterized by well-developed two-dimensional, or even three-dimensional, maze cave systems that provide maximum groundwater storage, high permeability, interstitial spaces approaching on a macro scale the conditions of porous media, and gentle groundwater hydraulic gradients (Huntoon 2000). The pulse-through hydraulics of this type of system cause fluctuations in spring discharge to be highly moderated and, in large basins, remarkably steady (Huntoon 2000). Groundwater in these systems tends to have elevated TDS content and temperature because most of the water has relatively long residence time in the aquifer due to large storage (Huntoon 2000).

Uplift-type karsts, such as those associated with partially saturated, unconfined conditions in the R-aquifer of the Kaibab Plateau, are characterized by simple vadose zone stream tubes along widely spaced extensional fault zones that provide minimal groundwater storage, localized large fracture permeability, and relatively steep hydraulic gradients (Huntoon 2000). The flow-through hydraulics of this type of partially saturated system cause spring discharge to be highly variable from season to season (Huntoon 2000). Groundwater in these systems tends to have relatively small TDS content and low temperature because most of the water is derived directly from seasonal recharge events and has relatively short residence time in the aquifer (Huntoon 2000).

Huntoon (2000:159) describes the difference between pulse-through (basin karst) and flow-through (uplift karst) systems by comparing porous media and surface water systems as follows:

> In porous media, recharge water moves into the aquifer and enters storage in the rock matrix causing hydraulic heads in the recharged zone to increase. The increased heads propagate toward the discharge points causing a steepening of the hydraulic gradient, thereby increasing flow rates through the aquifer. When the steepened gradient arrives at a spring, flow rates increase as the water in storage closest to the spring is pushed from the aquifer by piston flow. Notice, the water that flows from the spring does not contain much if any of the water which entered the aquifer during the recharge event. Rather it is older water in the most downstream part of the aquifer that is displaced out. The increased spring discharge is therefore called a Pulse-through event because it represents the arrival of the energy at the spring but not the recharge water itself. The recharged water is left behind in storage in the upstream part of the aquifer. As the energy from the recharge pulse passes through the aquifer, it is dissipated so that the spring response will be attenuated and drawn out over time.
>
> Surface water systems respond differently. A precipitation event in the upstream part of a basin produces a flash flood that moves down the channel as a hydraulic pulse in the form of a flood wave. When the pulse arrives at the downstream end of the basin, the water that caused the pulse is carried in it. The increased discharge represents a flow-through event. Comparable flow-through hydraulics operate in many unconfined karst aquifers because storage is minimal and the flood waters are actually coursing through relatively simple, well interconnected, open conduits analogous to surface streams. Actual flow rates approach surface water velocities. As a result, spring discharges from unconfined systems tend to be flashy.

It is likely that a range of conditions, with basin karst (pulse-through) and uplift karst (flow-through) at the endpoints, occurs in the Grand Canyon region (Huntoon 2000).

The potentiometric surface (level to which the groundwater would rise if not trapped in a confined aquifer) of the R-aquifer on the Coconino Plateau and directions of groundwater movement in the study area are shown in Figure 3.4-14 (modified from Bills et al. 2010). These contours were developed by extrapolation of observed data to show general directions of groundwater movement, but do not account for groundwater flow in specific fault and fracture zones. These contours generally illustrate the same general directions of flow as the groundwater flow model developed by Montgomery (1999) for the Coconino Plateau, which did simulate flow along major faults and fracture zones. Figure 3.4-14 also depicts a groundwater divide (shown as a blue dotted line) along the South Rim that is further from the Grand Canyon than was simulated by Montgomery (1999). North of the Grand Canyon, insufficient data are available to construct potentiometric level contours for the R-aquifer groundwater system; however, general directions of groundwater movement and general locations for groundwater divides are shown in Figure 3.4-14. Groundwater movement in the R-aquifer at each of the parcels is described in the following sections.

NORTH PARCEL

Groundwater data for the R-aquifer are sparse for the area north of Grand Canyon and the flow system is not as constrained by points of discharge at springs in the Grand Canyon watershed. However, a conceptual model for groundwater movement in the R-aquifer north of Grand Canyon has been developed based on groundwater levels in five R-aquifer wells on the North Parcel, the regional dip of geological formations (see Figures 3.4-4 and 3.4-6a [sections B-B' and C-C']), the location of major springs and fault zones (see Figures 3.4-5 and 3.4-11), and conceptual directions of R-aquifer groundwater movement developed by Bills et al. (2010), personal communication Don Bills, USGS (2010a), and Huntoon (1974, 1982, 2000). Indirect evidence suggests that R-aquifer groundwater in the North Parcel collects into solution-enhanced permeability features along fault zones and interconnected cave systems and thence generally moves along the pathways described below.

- Groundwater in the area of Kanab Creek and its tributaries likely moves chiefly southward toward springs in the lower reach of Kanab Creek. The area of the Hermit, Kanab North, Pigeon, Hack Canyon Complex, and Pinenut mines occurs within this flow regime (see Figure 3.4-14).
- Groundwater in the southernmost part of the North Parcel may move south toward small springs along the north wall of the Grand Canyon and potential discharge areas in the channel of the Colorado River, where it cuts into the R-aquifer (downstream from Kanab Creek) (see Figure 3.4-14). Spring discharge along the north wall of Grand Canyon in this reach is meager; therefore, it is believed that this flow regime is minor for the North Parcel.

  The large springs at Deer Creek and Thunder River shown east from the Sinyala Fault in Figure 3.4-11 are not part of the groundwater discharge from the North Parcel. These springs are southward points of discharge for groundwater collected by the West Kaibab Fault Zone (including the Muav and Sinyala faults) from the Kaibab Plateau. This relation is also illustrated in Figure 3.4-15.
- Groundwater in the westernmost and northwesternmost areas of the North Parcel may move northward into southern and central Utah along ancient (more than 200-million-year-old) preferential pathways that are believed to have existed during the formation of the breccia pipes in northern Arizona (see Figure 3.4-14). These pathways likely include deep, interconnected maze cave systems and major fault zones, such as the Sevier and Hurricane faults (see Figure 3.4-9). The R-aquifer dips deeply northward from near the Grand Canyon to thousands of feet in depth (see Figure 3.4-4) and does not directly feed springs along the Virgin River north of the North Parcel (Cordova 1981; Dutson 2005). Only oil and gas wells are known to penetrate to these depths in Utah, where the R-aquifer is not considered a viable drinking water supply. The large spring system (total flow of more than 4,100 gpm) that discharges into the Virgin River, where it intersects the Hurricane Fault near Hurricane, Utah issues from the Toroweap Formation.
- Similarly, groundwater in the northeasternmost part of the North Parcel may also move northward into Utah by collecting into major structural preferential pathways, such as the West Kaibab Fault Zone (including the Muav Fault) (see Figures 3.4-9 and 3.4-14).

Groundwater divides occur between these directions of groundwater movement in the North Parcel. Although available data are not sufficient to determine the exact locations for the divides, the conceptual locations are sufficient for the purposes of describing relative groundwater movement.

The R-aquifer crops out along the Virgin River near Littlefield, Arizona and upstream in the lower Virgin River gorge in the northwest corner of Arizona (see Figure 3.4-9). Discharge from springs related to these outcrops has been reported by various sources to range from about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex (personal communication, Don Bills, USGS 2010b). The potential for a hydraulic connection in the R-aquifer between the North Parcel and these spring complexes is not known. Several major north-trending fault zones, including the Sevier, Toroweap, Hurricane, and Main Street faults, occur between the North Parcel and the Virgin River area in northwest Arizona (see Figure 3.4-9). These faults are thought to function like the Mesa Butte Fault Zone south of the Grand Canyon, which provides a preferential pathway where groundwater is intercepted and conveyed along the fault zone to spring systems along the Little Colorado River to the north and the Verde River valley to the south (see Figure 3.4-3). Another example is the West Kaibab Fault Zone (including the Muav and Sinyala faults), which is believed to intercept westward moving groundwater from the Kaibab Plateau and convey it south and north. The fault zones west of the North Parcel, as well as ancient cave systems, likely collect and convey groundwater chiefly north toward central and southern Utah and lesser amounts south toward the Grand Canyon, and may prevent or limit westward movement of R-aquifer groundwater from the North Parcel across the faults to the Virgin River area in northwest Arizona. In addition, although the R-aquifer and other formations at the north end of the Virgin Mountains are abundantly faulted and fractured, the main body of the north-south-trending crystalline bedrock core of the Virgin Mountains east and southeast from the Littlefield spring complex likely functions as a barrier to east-west groundwater movement. Nonetheless, it is possible that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona. However, if such a connection does occur, the contribution to large spring flow along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small.

Figure 3.4-15 shows the conceptual groundwater flow regime developed by Huntoon (1974) for the R-aquifer beneath the Kaibab Plateau, which is a source of recharge for the aquifer east of Kanab Creek. Huntoon (1974, 1982, 2000) indicated the occurrence of several R-aquifer groundwater divides in the Kaibab Plateau caused by collection of groundwater into solution-enhanced permeability features along principal fault and fracture zones, many of which eventually circulate to springs in the Grand Canyon and its tributaries. Huntoon (2000) indicates that the West Kaibab Fault Zone intercepts substantial R-aquifer recharge and groundwater flow moving west in the Kaibab Plateau and conveys the water along the fault zone to the Tapeats Creek and Thunder River spring system, thereby capturing groundwater that might have provided substantial spring flow into the Kanab Creek system. This interpretation explains the lack of large springs west from the fault zone and the relatively limited discharge of R-aquifer springs near the mouth of Kanab Creek. Therefore, exploration and development activities in the North Parcel can not affect the springs that are supported by recharge and groundwater movement in the Kaibab Plateau.

EAST PARCEL

There are no data available to define the groundwater flow regime in the R-aquifer beneath the East Parcel. However, the presence of a major source of recharge to the west on the Kaibab Plateau and the location of a major R-aquifer discharge area along the Fence Fault complex reach of Marble Canyon, including Vasey’s Paradise, suggest that groundwater generally moves along preferential pathways from west to east or southeast beneath the East Parcel (see Figure 3.4-14). The flow pathway may be somewhat convoluted as a result of the north and northwest orientation of the faults and folds in the East Parcel area. Large quantities of groundwater discharge from the R-aquifer along the Fence Fault and at Vasey’s Paradise (see Figure 3.4-12). Underflow in the R-aquifer may occur beneath the river channel in Marble Canyon, and unknown quantities of groundwater may discharge directly into the bottom of the Colorado River, where the aquifer crops out in the river channel downstream of North Canyon (Huntoon 1981). R-aquifer groundwater in the small area at the northernmost extent of the East Parcel may move northward into Utah, but like groundwater in the North Parcel, it is unlikely to discharge to any of the large springs along the Virgin River.

SOUTH PARCEL

Most of the South Parcel lies in the R-aquifer groundwater sub-basin of Havasu Springs (see Figures 3.4-13 and 3.4-14). R-aquifer groundwater south and west of the groundwater divide flows downgradient to the south, southwest, and west, eventually discharging to the large Havasu Springs complex (see Figures 3.4-13 and 3.4-14).

R-aquifer groundwater north of the groundwater divide and the Grandview Monocline flows downgradient to the east and northeast, discharging to the Little Colorado River and the large Blue Springs complex (see Figures 3.4-13 and 3.4-14). Based on groundwater contours shown on Figure 3.4-14, there may be some R-aquifer groundwater north of the Grandview Monocline that flows northward to discharge at small springs and seeps along the south wall of Grand Canyon. Fault and fracture zones along the northern extent of the monocline likely provide pathways for R-aquifer groundwater to discharge at small springs and seeps along the south wall of Grand Canyon, such as Miner's and O'Neill springs. The Grandview Mine breccia pipe is located within the monocline between these two springs (Alter et al. 2009). It should be noted that the outcrop pattern of the Redwall Limestone shown on maps in this section of the EIS is offset in some areas with respect to the locations for R-aquifer springs shown on the maps because of map scale and map corrections that are not yet available from the USGS; some R-aquifer springs erroneously appear to be above the Redwall Limestone.

In the northern part of the South Parcel, which lies in the Havasu Creek surface water drainage basin, R-aquifer groundwater north of the groundwater divide, which is near and approximately parallel to the South Rim of Grand Canyon, flows north toward the Colorado River and springs and R-aquifer seeps along the south wall of Grand Canyon (see Figures 3.4-13 and 3.4-14). These springs include the Hermit Springs and Garden Spring complexes, each of which has an aggregate discharge of about 300 gpm. It should be noted that each of the groundwater drainage areas that support the Hermit Springs and Garden Springs complexes likely extend southwestward along the associated southwest-trending fault zones that intersect the Grand Canyon at these locations. These groundwater drainage areas may extend farther southwest than indicated by the R-aquifer groundwater divide estimated by Bills et al. (2007) and shown in Figure 3.4-14.

Discharge from R-Aquifer Springs

Groundwater in the R-aquifer south of the Colorado River discharges chiefly at the Blue and Havasu spring complexes. North of the Colorado River, the R-aquifer discharges chiefly at Tapeats Creek, Thunder River, Kanab Creek, Bright Angel Creek, Deer Creek, Shinumo Creek, the Fence Fault complex, and Vasey's Paradise. There is also significant, but undefined, groundwater discharge, as well as underflow, from the R-aquifer in Marble Canyon. Assuming steady-state conditions, the amount of recharge to and groundwater movement through the R-aquifer can be estimated by summing discharge from large springs that occur on the margins of the plateaus. Appendix E provides a summary of reported locations and discharge rates for springs and seeps.

Recharge from infiltration of precipitation in local drainage catchment basins along both rims of the Grand Canyon is very important to the occurrence and sustainability of local water-bearing zones that support the discharge at many small springs and seeps and at a few moderate-sized springs within the Grand Canyon or its tributary canyons. The drainage area necessary to support the small but environmentally important discharge from these springs and seeps is limited and can be contained within the near-rim areas of more weathered and fractured rock. As described previously, the small springs and seeps are considered to be poorly connected or in some cases not connected hydraulically to the regional circulation systems of the R-aquifer (Montgomery 1996, 1999; U.S. Bureau of Reclamation 2002). The results of isotope studies reported by Monroe et al. (2005) and Bills et al. (2007) suggest that a fraction of the water from several of the springs may have slowly percolated downward from land surface and/or flowed from more distant parts of the aquifer, and that the small, local drainage basins at the Canyon rim may not be the only source of water for these springs.

Rihs et al. (2004) studied several springs discharging from the R-aquifer along the South Rim of Grand Canyon. They concluded that there was a significant decreasing trend in discharge from some springs but not others. The cause of the decrease was not identified and could be the result of a complex set of circumstances, including decreasing precipitation trends and pumping from the aquifer at Tusayan since 1989. This decrease is not attributed to uranium mining operations because there have been no uranium mining or groundwater withdrawals from the R-aquifer for mining in the South Parcel or adjacent areas during the period of the Rihs et al. (2004) study, and only minor use of the Canyon Mine well since it was drilled.

Yield from Wells

Records indicate that only 13 wells are completed in the R-aquifer in the study area (see Table 3.4-1, Figure 3.4-9). Many more wells are completed in the perched aquifers and yield small quantities of water with varying reliability and chemical quality. Records for pumping rates at wells are given in Appendix D. It should be emphasized that the reported pumping capacity of a well is often limited to the size of the pump and the diameter of the well casing, rather than the capacity the aquifer.

Reported pump capacity for all wells in the study area ranges from 0.1 to 1,200 gpm. The highest pump capacities reported (600 to 1,200 gpm) are for several water wells located far to the northeast of the East Parcel in the vicinity of Lake Powell. Reported pump capacities for water wells completed in Mesozoic-age geological units in North and East parcels range from 0.5 to 600 gpm. Three water wells near Fredonia, Arizona have reported pump capacities of between 50 and 400 gpm and are likely completed in the Kaibab and/or Toroweap formations where these units represent a viable aquifer. Other water wells completed in perched aquifers in the three parcels and their immediate vicinity have recorded pump capacities of 15 gpm or less; pump capacities of these wells average about 4 gpm. Reported pumping rates for R-aquifer water wells range from 5 to 89 gpm; average rate is about 29 gpm (see Table 3.4-1).

In most parts of the study area, long-term pumping of significant volumes of groundwater from R-aquifer wells within the drainage basins of R-aquifer springs would intercept groundwater that, in the absence of pumping, would have discharged at these springs. It should be emphasized that because of complex subsurface relationships, some springs would be affected more than others, and some would not be affected at all. If pumping were to continue for a sufficiently long period at a rate less than the total groundwater recharge rate for the system, a new condition of dynamic equilibrium would be established where the average rate of groundwater discharge at the springs would be equal to the average rate of recharge minus the average rate of groundwater pumping at the wells. Groundwater levels would slowly stabilize in the aquifer at a level that is less than the pre-pumping level. However, if the rate of long-term pumping exceeds the rate of recharge, groundwater would continue to be removed from storage, and groundwater levels and spring flow reductions would continue until groundwater levels eventually decline to the bottom of the pumps in the wells. In either case, the amount and duration of impact to springs would depend on site-specific conditions. In some cases, springs could dry up. If pumping stopped at any point, recharge would eventually replenish the aquifer over time and re-establish pre-pumping water levels and discharge rates at the affected springs.

3.4.7 Water Quality

Natural processes and human activities (including improperly abandoned mines and improperly disposed mine waste or waste rock) can cause concentrations of dissolved trace elements and radionuclides to be elevated in groundwater and surface water. Water chemistry data for wells, springs, seeps, and mine sumps within the study area have been obtained, compiled, and reported by numerous academic, government, and industry sources. The most relevant of these data have been reviewed and compiled for the EIS. Uranium and uranium decay products are the principal mine-related constituents of concern for water quality in the proposed withdrawal area. Other trace elements reported to be associated with uranium in mineralized breccia pipes include antimony, arsenic, barium, cadmium, cobalt, copper, lead, molybdenum, nickel, silver, strontium, vanadium, and zinc (Wenrich et al. 1994). However, except for arsenic, not all of these constituents are known to necessarily correlate with dissolved uranium in water because of a lack of data. Thus, only impacts to water resources related to uranium and arsenic are analyzed in Chapter 4.

Bills et al. (2010) evaluated historic water quality data compiled for the region to identify exceedances of drinking water standards and health-based guidance levels for the following additional constituents of concern: arsenic, lead, mercury, and molybdenum. The following uranium-series decay products were identified by Hinck et al. (2010) to present a potential hazard to fish and wildlife in the area if present in the environment: uranium, thallium, thorium, bismuth, radium, radon, protactinium, polonium, actinium, and francium. Unfortunately, very sparse data exist for these radionuclides other than uranium in the study area, so uranium data must be used as a proxy for assessing potential levels of decay-chain products. Hinck et al. (2010) report that species in the region may be susceptible to adverse effects at uranium concentrations ranging from 0.57 to 46,000 micrograms per liter (μg/L). Water quality thresholds for wildlife are discussed in detail in Section 3.7.

Bills et al. (2010) conducted a recent, comprehensive survey of water chemistry data and compilation of historical uranium data for the study area. Historical water-chemistry data from selected data sources were compiled and reviewed by USGS for streams, wells, and both perched aquifer and R-aquifer springs. In addition, in 2009, new water-chemistry data were obtained by USGS and NPS at 24 sites to augment historical data for the three parcels. USGS reviewed more than 1,000 water samples obtained from more than 400 sites in the Grand Canyon and surrounding regions. The results of this USGS study form an important part of the database used for analysis of water quality for this chapter of the EIS; additional analyses were compiled and reviewed for the EIS.

Numerous mineralized breccia pipes are exposed in the walls of the Grand Canyon and adjoining canyons. Many others, located some distance from canyon walls, remain undisturbed (see Figure 3.4-5). Uranium and associated minerals may occur naturally in groundwater in northern Arizona and southern Utah. Bills et al. (2010) reported that concentrations of dissolved uranium were less than 5 μg/L for about 66% of all historic samples in their data set and were less than 20 μg/L for about 95% of all historic samples in their data set. Their historic data set consisted of 1,014 samples from 428 documented sites that have analyses for dissolved uranium, including 480 samples from 63 stream locations, 385 samples from 288 springs, 138 samples from 74 wells, and 11 samples from three mines.

The EPA has established National Primary Drinking Water Regulations that set mandatory water quality standards for drinking water contaminants. These are enforceable standards called maximum contaminant levels (MCLs), which are established to protect the public against consumption of drinking water contaminants that present a risk to human health. An MCL is the maximum allowable amount of a contaminant in drinking water that is delivered to the consumer. In addition, EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for 15 contaminants. EPA does not enforce these secondary MCLs. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the secondary MCL.

Bills et al. (2010) reported that the results of chemical analyses indicated that, at about 16% of the sites, concentrations exceeded either the primary or secondary MCL for a few major ions and trace elements such as arsenic, iron, lead, manganese, sulfate, radium, and uranium. Arsenic and lead are commonly associated with uranium deposits. The average concentration of arsenic was found to exceed the primary MCL at 70 sites, and lead concentrations were determined to exceed the primary MCL at only three sites in the data collected and compiled by the USGS.

Sample data for dissolved uranium content of the Colorado River were also compiled in the USGS Report (Bills et al. 2010:Figure 15, Appendix 4). These data indicate that the dissolved uranium concentration of the river was about 3 to 4 µg/L from January 1996 through June 1998 at Lees Ferry, which is immediately upstream from the East Parcel. These concentrations are similar to those detected downstream of the withdrawal area at Diamond Creek; dissolved uranium averaged 3.2 µg/L at Lees Ferry and 3.1 µg/L at Diamond Creek from 1996 through 1998.

Water type varies throughout the study area. Water quality results reported by Bills et al. (2010) were generally categorized as shown in Table 3.4-3, based on the principal anions and cations.

Table 3.4-3. Summary of Water Types

Aquifer or River	Location	Water Type
Perched Aquifer	North of Colorado River	$CaMg\text{-}SO_4$
Regional (R-aquifer)	North of Colorado River	$Ca\text{-}HCO_3$
Perched Aquifer	South of Colorado River	$CaMg\text{-}HCO_3$
Regional (R-aquifer)	South of Colorado River	$CaMg\text{-}HCO_3$
Regional (R-aquifer)	West part of Grand Canyon	$CaMg\text{-}SO_4$
Regional (R-aquifer)	Little Colorado River (at Blue Springs)	Na-Cl
Regional (R-aquifer)	Marble Canyon	$Ca\text{-}HCO_3$
Regional (R-aquifer)	Southwest of Kaibab Plateau	$Ca\text{-}HCO_3$
Regional (R-aquifer)	Kanab Plateau	$Ca\text{-}HCO_3$
Little Colorado River	Cameron	$Na\text{-}SO_4$

Source: Bills et al. (2010)

Note: Ca = Calcium; Cl = Chloride; HCO_3 = Bicarbonate; Mg = Magnesium; Na = Sodium; SO_4 = Sulfate

A principal conclusion of the 2010 USGS report was that "observation of groundwater-chemistry relations between concentration and mining condition (no exploration or development activity, active mines on interim management, or reclaimed mine areas) were limited and inconclusive" (Bills et al. 2010:194).

The ambient water quality of perched groundwater near mines is generally of poor quality as a result of mineralization from the ore bodies. Groundwater that is contained within the breccia pipes (connate water) is also generally of very poor quality as a result of mineralization (personal communication, Roger Smith, formerly with Energy Nuclear Fuels, Inc. 2010).

Water sample data compiled for the EIS include results for TDS content, flow rate at springs, dissolved arsenic, dissolved uranium, and a small number of dissolved lead analyses. Analytical results for uranium, arsenic, and lead were generally composed of filtered samples that were analyzed for dissolved constituents. Sources for TDS, flow rate, arsenic, and uranium data that were compiled include USGS (2010d); Bills et al. (2010); Grand Canyon National Park (2010a); ADWR (2009b); Grand Canyon Wildlands Council, Inc. (2002); Fitzgerald (1996); Montgomery (1993a, 1993b); and Woodward-Clyde Consultants (1985). In addition, historical data on selected sites, including mine wells and sumps, reported in Bills et al. (2010) for arsenic and uranium were included in the compilation. Sample results for dissolved lead were obtained from USGS (2010d). Additional information from the EPA's STORET database, primarily composed of site information, was used to supplement data compiled from the above sources (EPA 2010l).

Locations and estimates of discharge rate for all sample locations for springs and seeps, as well as for selected sample locations for streams compiled for the EIS, are summarized in Appendix E. Information compiled for locations of all water quality sampling and flow rate estimates is summarized in Appendix F. Sample statistics for each sample location are summarized in Appendix G for the study area; statistics include the total number of reported sample results for each summarized constituent, and the minimum, maximum, and average parameter values for each constituent.

Results for water quality analyses were compiled from the sources noted above for a total of 687 sampling locations in the water resources study area and for 6-mile buffers around each of the parcels. These buffer areas allow for characterization of features adjacent to the parcels that may have a relationship with the parcels. For example, the numerous small springs and streams located north of the Grand Canyon's South Rim are outside the South Parcel but may have drainage areas that overlap portions of the South Parcel. Of the total number of sites for the regional study area with sample results, 265 were classified as discharging from aquifers composed of Mesozoic rock, 154 sites were classified as discharging from the perched aquifer, 148 sites were classified as discharging from the R-aquifer, 32 were classified as discharging from a source below the R-aquifer, five sites were associated with mine seepage, and the remaining 83 sites were from a zone that is not classified under a specific aquifer; samples were obtained from wells, springs, and streams. Sample statistics are summarized in Table 3.4-4 for the study area and proposed withdrawal area; statistics include the total number of sites in each aquifer or sample source category, the number of sites constituting each summarized constituent, and the minimum, maximum, and average parameter values for each constituent (averages consist of the numeric mean of all parameter averages calculated for each site).

Results reported for TDS are from laboratory analyses, where available. Where laboratory results were not available, TDS was estimated by multiplying measured electrical conductivity of the water sample by a conversion factor of 0.65 (Hem 1985). Table 3.4-4 summarizes relevant information provided in Appendix G regarding parameter values reported for the combined data set, including all sample sources (wells, springs, and streams) classified as being associated with the perched and regional aquifer systems.

For all samples in the water resources study area, samples for the perched aquifer system showed that concentrations of the principal constituents ranged from 17 to 7,500 milligrams per liter (mg/L) for TDS, 0.4 to 241.6 µg/L for arsenic, and 0.02 to 44 µg/L for uranium. For all samples in the R-aquifer system, concentrations of the principal constituents ranged from 70 to 25,000 mg/L for TDS, 0.11 to 220 µg/L for arsenic, and 0.15 to 400 µg/L for uranium. Higher concentrations of TDS in groundwater and springs generally indicate that the rock unit in which the groundwater resides has more soluble minerals and/or that the groundwater has resided in the aquifer for longer periods.

Estimated background concentrations of parameters stored in the database for the entire water resources study area are provided by calculating summary statistics for all sample sites, regardless of aquifer or source (Table 3.4-5). However, in order to obtain statistics representative of natural conditions, samples that are known to be affected by mining operations (such as samples of mine seepage obtained from mine sumps and shafts) and samples obtained from water that may be impacted by mining (such as samples obtained from Horn Creek [see Appendix G]) were not included in the calculations.

North Parcel

Results for water quality analyses were compiled for a total of 118 sampling locations in the North Parcel and for a 6-mile buffer region outside the area. Of these locations, 64 were classified as discharging from aquifers composed of Mesozoic rock, 34 sites were classified as discharging from the perched aquifer, nine sites were classified as discharging from the R-aquifer, no sites were classified as being below the R-aquifer, seven sites were classified as stream sample sites, and the remaining four sites were classified as mine seepage.

Table 3.4-4. Summary of Statistics for Water Quality Samples

Sample Source	Total Number of Sites	TDS (mg/L) Min	TDS (mg/L) Max	TDS (mg/L) Avg	Number of Sites with TDS Results	Arsenic (µg/L) Min	Arsenic (µg/L) Max	Arsenic (µg/L) Avg	Number of Sites with Arsenic results	Uranium (µg/L) Min	Uranium (µg/L) Max	Uranium (µg/L) Avg	Number of Sites with Uranium Results	Flow Rate (gpm) Min	Flow Rate (gpm) Max*	Flow Rate (gpm) Avg*	Number of Sites with Flow Rate Results
All Data within Water Resources Study Area																	
Mesozoic	265	79	12,600	1,097	153	0.41	105.6	15.6	21	0.00	249.6	11.6	70	0	673	13	114
Perched	154	19	7,750	908	98	0.4	241.6	22.0	32	0.02	44	5.3	59	0	673	10	89
R-aquifer	148	70	25,000	1,066	110	0.11	220	22.5	61	0.15	400	10.9	92	0	48,000	1,460	106
Below Regional	32	109	8,320	1,212	24	6	350	86.2	12	1.5	29	10.8	21	0	5,270	209	18
Mine seepage	5	1,920	1,920	1,920	1	5	1,090	152.6	5	20.7	36,600	7,693.6	5	–	–	–	0
N/A (Stream)	66	87	3,560	656	47	0.5	310	40.9	13	0.14	29.21	5.8	29	0	2,200,000	11,100	45
N/D (Well)	17	117	3,150	1,401	8	0.5	248.1	116.4	7	1.21	13.47	3.7	9	–	–	–	0
North Parcel																	
Mesozoic	64	79	6,810	1,253	37	0.5	4	2.4	8	0.11	249.6	24.0	24	0	170	25	19
Perched	34	293	3,380	1,486	23	0.4	28	4.6	13	0.50	44	10.3	19	0	90	9	24
R-aquifer	9	455	3,970	1,418	8	0.5	34	6.9	8	0.15	24	4.7	8	1	274	65	8
Mine seepage	4	1,920	1,920	1,920	1	5	1,090	168.2	4	20.7	36,600	9,462.1	4	–	–	–	0
N/A (Stream)	7	820	3,560	2,007	6	0.5	10	1.5	6	0.5	18.9	6.5	7	189	31,900	8,530	5
East Parcel																	
Mesozoic	56	109	4,200	607	30	–	–	–	0	0.6	5.05	1.9	5	0	18	2	44
Perched	3	897	897	897	1	1.44	5	3.2	2	0.77	4.64	2.1	3	0	0	0	1
R-aquifer	14	163	1,600	777	14	1.3	21	9.6	13	0.5	2.5	1.6	13	1	4,480	391	14
N/D (Well)	1	2,353	2,353	2,353	1	–	–	–	0	–	–	–	0	–	–	–	0
South Parcel																	
Perched	8	145	1,120	525	6	0.5	0.5	0.5	1	0.6	7.2	3.4	3	1	1	1	3
R-aquifer	30	70	1,829	372	27	0.26	20	8.8	8	1.06	400	29.3	23	0	359	45	22
Below regional	11	275	1,235	581	10	54	54	54	1	1.75	18	7.3	9	0	54	6	8
Mine seepage	1	–	–	–	0	90	90	90	1	620	620	620	1	–	–	–	0
N/A (Stream)	16	166	853	424	9	–	–	–	0	1.4	29.21	7.6	9	0	1,020	128	9
N/D (Well)	1	–	–	–	0	237.3	237.3	237.3	1	3.12	3.12	3.1	1	–	–	–	0

Notes:
Samples reported for the proposed withdrawal area include all results within 6 miles of the parcel boundaries.
Avg = average value.
Min = minimum value.
Max = maximum value.
N/A = not applicable.
N/D = not determined.
– = Data not available.
* Three significant figures assumed for all flow rate results.

Table 3.4-5. Summary Statistics for All Non-mine-Related Samples

Parameter	Number of Sites	Minimum	Maximum	Average
TDS (mg/L)	438	19	25,000	1,015
Arsenic (µg/L)	146	0.11	350	32.8
Uranium (µg/L)	275	0.001	249.6	7.16
Lead (µg/L)	70	0.03	210	8.7

For the North Parcel, discharge rate and TDS results are shown in Figure 3.4-16a, arsenic results are shown in Figure 3.4-16b, and uranium results are shown in Figure 3.4-16c. For the perched aquifer system, concentrations of the principal constituents ranged from 293 to 3,380 mg/L for TDS, 0.4 to 28 µg/L for arsenic, and 0.5 to 44 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 455 to 3,970 mg/L for TDS, 0.5 to 34 µg/L for arsenic, and 0.15 to 24 µg/L for uranium.

East Parcel

Results for water quality analyses were compiled for a total of 74 sampling locations in the East Parcel and for a 6-mile buffer region outside the area. Of these locations, 56 were classified as discharging from aquifers composed of Mesozoic rock, three sites were classified as discharging from the perched aquifer, 14 sites were classified as discharging from the R-aquifer, no sites were classified as being below the R-aquifer, and one site was from zones not classified as being associated with a specific aquifer.

For the East Parcel, discharge rate and TDS results are shown in Figure 3.4-17a, arsenic results are shown in Figure 3.4-17b, and uranium results are shown in Figure 3.4-17c. For the perched aquifer system, concentrations of the principal constituents were 897 mg/L for TDS, ranged from 1.44 to 5 µg/L for arsenic, and ranged from 0.77 to 4.64 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 163 to 1,600 mg/L for TDS, from 1.3 to 21 µg/L for arsenic, and from 0.5 to 2.5 µg/L for uranium.

South Parcel

Results for water quality analyses were compiled for a total of 67 sampling locations in the South Parcel and for a 6-mile buffer region outside the area. Of these locations, none were classified as discharging from aquifers composed of Mesozoic rock, eight sites were classified as discharging from the perched aquifer, 30 sites were classified as discharging from the R-aquifer, 11 sites were classified as being below the R-aquifer, 16 sites were classified as stream sample sites, one site was classified as mine seepage, and the remaining site was from zones not classified as being associated with a specific aquifer.

For the South Parcel, discharge rate and TDS results are shown in Figure 3.4-18a, arsenic results are shown in Figure 3.4-18b, and uranium results are shown in Figure 3.4-18c. For the perched aquifer system, concentrations of the principal constituents ranged from 145 to 1,120 mg/L for TDS, 0.5 µg/L for arsenic (only one sample available), and from 0.6 to 7.2 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 70 to 1,829 mg/L for TDS, from 0.26 to 20 µg/L for arsenic, and from 1.06 to 400 µg/L for uranium. If the water samples from Horn Creek, which is believed to be impacted by mine drainage as discussed in the next section, are excluded, the maximum uranium concentration is 31.2 µg/L and the average uranium concentration is 5.6 µg/L.

Legacy Impacts to Water from Uranium Mining

Uranium concentrations exceeding the regional average of about 7 µg/L detected in groundwater or springs near existing and/or former mines do not necessarily indicate that the water is impacted by exploration and development activities. Naturally occurring concentrations of uranium at specific springs or stream sites are likely to vary from site to site because of variability in aquifer materials, source waters, and environmental conditions (reduction-oxidation potential). Site-specific uranium concentrations may be higher than the regional average of 7 µg/L. For example, samples collected at Pigeon Spring in 1982 indicate that the uranium content of the spring was 44 µg/L prior to initiation of mining (Hopkins et al. 1984b). Thus, concentrations of contaminants of concern at specific sites should be considered in light of both regional average and maximum values at sites of a given type when evaluating the magnitude of a potential impact. Ideally, background conditions and their variability at sites of concern prior to initiation of mining must be known with a reasonable level of confidence to infer that an impact has likely occurred. There are no sample results in the water quality database that meet these requirements, except for samples obtained from the Canyon Mine well.

Under certain circumstances, impacts to water quality may be inferred in the absence of pre-mining data. In hydrologic systems poorly connected to the regional groundwater circulation system in the R-aquifer, it is unlikely that discharge to springs is substantially mixed with groundwater from distant sources. The isotopic composition of uranium in water from such systems may be used to evaluate whether high uranium concentrations result from the natural dissolution of uranium-bearing rocks or from anthropogenic activities at uranium mines (Appendix H). Samples exhibiting high ^{234}U activity relative to ^{238}U activity are indicative of ambient groundwater because of the preferential mobility of ^{234}U in natural waters. Conversely, samples having ^{234}U activity approximately equal to ^{238}U activity represent conditions of aggressive water-to-rock interaction symptomatic of water impacted by mine drainage. Isotopic and dissolved uranium data compiled for the study area and Colorado River indicate that only samples collected from Horn Creek springs, which originate from the R-aquifer about ½ mile or less north of the Orphan Lode Mine, have high concentrations of dissolved uranium (>30 µg/L) and an $^{234}U/^{238}U$ activity ratio near one. Apparently, surface water and/or perched groundwater seepage into the abandoned, unreclaimed mine workings of the Orphan Lode Mine have interacted with mine waste and/or disturbed ore deposits to generate elevated concentrations of uranium in water that has moved vertically downward from the mine openings into the R-aquifer. Additional monitoring data are necessary to rule out the possibility that groundwater in locations other than Horn Creek springs may also be impacted from uranium mining because potential mixing of impacted water with native groundwater may mask the isotopic signature.

3.4.8 Resource Condition Indicators for Water Resources

Based on the information presented in Chapter 3, the resource condition indicators for water resources to be carried forward for analysis in Chapter 4 include the following:

- **Perched Aquifer Water Quantity.** Quantity of water discharge at springs and wells supported by perched groundwater zones that may be depleted by drainage into nearby subsurface openings related to mining.
- **Perched Aquifer Water Quality.** Chemical quality of water discharge at springs and wells supported by perched groundwater zones that may be affected by operations at nearby mine sites, with emphasis on metals.

- **R-aquifer[1] Water Quantity.** Quantity of water discharge at springs and deep wells supported by the R-aquifer system that may be depleted by mine water supply wells.
- **R-aquifer Water Quality.** Chemical quality of water discharge at springs and deep wells supported by the R-aquifer system that may be affected by operations at mine sites, with emphasis on metals.
- **Condition of Surface Waters.** Quantity and chemical quality (with emphasis on metals), and hydrologic function of perennial and ephemeral surface drainages that receive discharge from springs and/or surface water runoff. Quantity and quality of water retained in non-mine surface impoundments.

3.5 SOIL RESOURCES

This section provides a description of existing soil resources in the vicinity of the proposed withdrawal area and the current value of resource condition indicators that will be the basis for evaluating impacts in Chapter 4. The description is based on review and compilation of available data for selected soil properties obtained from the National Resources Conservation Service (NRCS), Forest Service, and BLM, as well as review of information from numerous previous investigations of the Northern Arizona region, including those by the USGS, mining companies, and other consultants.

3.5.1 Soil Resource Condition Indicators

Soil information obtained from NRCS soil surveys for the North and East parcels and from TES results for the South Parcel was reviewed to determine the conditions likely to be affected as a result of the construction, operation, and maintenance of anticipated future access roads, utility corridors, mine facilities, and exploration drill sites in the proposed withdrawal area, as outlined in the RFD scenario. These conditions include the following:

- **Soil Disturbance.** Soil physical properties would be expected to be affected from the surface disturbance that is required for the development of mine facilities, drill sites, access roads, and power lines. The indicator values are the anticipated acreage (area) of disturbed soils. Existing soil disturbance associated with previous and current mining is about 713 acres, of which roughly 603 acres have been reclaimed.
- **Soil Erosion.** Rates of soil loss would be expected to increase as a result of vegetation removal, soil compaction, and changes in drainage patterns related to anticipated surface disturbance. The indicators are qualitative evaluations of potential increased erosion rates, and the extent of off-site effects, relative to undisturbed conditions. These impacts are assessed relative to erosion hazard ratings, which identify areas of erosion-sensitive soils; such areas are typified by steep topography and/or thin soils.
- **Soil Contamination.** Soil chemical quality would be expected to be altered by distribution of mine-related constituents in soil from erosion and subsequent deposition of mine waste rock or ore from water and/or wind action, or leakage from detention ponds in the vicinity of each mine site. Indicators values are expected levels of mine-related contaminants in soil compared to background levels and ADEQ Soil Remediation Levels (SRLs). Investigation of legacy mining impacts on the North Parcel determined that the two most abundant elements associated with

[1] The R-aquifer is the regional carbonate aquifer composed of the Redwall Limestone, Temple Butte Formation, undifferentiated Cambrian dolomites, and Muav Limestone; this aquifer is also referred to as the Redwall-Muav aquifer or the regional aquifer. Perched aquifers are separated from the R-aquifer by low-permeability confining layers and are typically thin and discontinuous.

uranium mining detected in impacted soils are uranium and arsenic (Otton et al. 2010). This study indicated average concentrations of uranium and arsenic in soils on-site (reclaimed) and off-site ranged from below regional ambient levels to as much as one order of magnitude above ambient levels. Soils in the area surrounding reclaimed mines and those in operation for a short time were generally less impacted than unreclaimed mines or mines in operation for longer periods. Although concentrations of the constituents of concern exceeded ambient conditions at some locations, concentrations were generally below the SRL for uranium. Concentrations were generally above the SRL for arsenic but below the maximum reported concentration for an unmined, mineralized breccia pipe in the study area.

3.5.2 General Description of Study Area

Soil types within the study area vary widely, reflecting differences in the environmental and geomorphic conditions under which soils were formed and differences in the parent materials. The environmental and geomorphic conditions are controlled primarily by the topography of the region, which ranges from nearly level valley bottoms and gently sloping plateaus to vertical cliffs; elevations range from less than 2,000 feet amsl in the Grand Canyon to more than 8,000 feet amsl on the Kaibab Plateau. Although the proposed withdrawal area is characterized primarily by plateaus, several canyons associated with Kanab Creek are incised into the Kanab Plateau in the North Parcel, and the Marble Canyon section of the Grand Canyon, including several tributary canyons, is located directly adjacent to the East Parcel. Soil characteristics range from shallow, weakly developed, rocky soils on plateaus, cliffs, and ridges to deeper, more productive soils on alluvial fans and in valley bottoms. In general, soils in the proposed withdrawal area are fine textured and contain a wide range of rock fragments, both internally and at the surface. The dominant parent materials that occur in the proposed withdrawal area are sedimentary rocks, including sandstone, carbonate (chiefly limestone and dolomite), mudstone, shale, and gypsum. Igneous rocks, including basalt, basalt cinders, and granite, are also prevalent (Hendricks 1985).

The dominant soil orders that occur in the proposed withdrawal area are Alfisols, Aridisols, Entisols, and Mollisols; these soil orders are described by Hendricks (1985) and via personal communication (personal communication, Christopher MacDonald, Forest Service 2010a), as follows:

- Alfisols and Aridisols are the more developed soils of arid and semi-arid environments, with Aridisols occurring at lower elevations and in drier climates. Alfisols generally form under forest vegetation and have subsoils composed primarily of clays. Aridisols are typically light colored and very low in organic matter content.
- Entisols occur in young landscapes and develop from parent materials resistant to weathering. These soils are commonly shallow and overlie rock on steep slopes.
- Mollisols are typically dark-colored soils with high organic matter content near the surface and occur at higher elevations under subhumid to semiarid climates in landscapes dominated by grassland vegetation.

Soils identified in the study area have a mesic soil temperature regime (mean annual soil temperature of about 46°F–59°F) and an aridic (6–10 inches annual precipitation) to semiaridic (10–15 inches annual precipitation) soil moisture regime. Soil mineralogy is generally carbonatic, mixed, or smectitic (NRCS 2006a). Some areas also exhibit a carbonatic gypsic mineralogy (personal communication, Robert Smith, BLM 2010b).

3.5.3 Soil Extents and Characteristics

Available soil surveys were obtained from the NRCS State Soil Geographic (STATSGO) and Soil Survey Geographic (SSURGO) databases,[2] and Terrestrial Ecosystem Survey (TES) information was obtained from the Forest Service, Kaibab National Forest (Brewer et al. 1991).[3] Soil surveys and terrestrial ecosystem surveys are conducted in accordance with the National Cooperative Soil Survey, which is a nationwide partnership of federal, regional, state, and local agencies, along with private entities and institutions. This partnership works to cooperatively investigate, inventory, document, classify, interpret, disseminate, and publish information about soils of the United States and its trust territories and commonwealths (NRCS 2007).

The NRCS has completed detailed soil surveys that encompass the North and East parcels. The Kaibab National Forest has completed a detailed TES that encompasses the South Parcel. Detailed soil data were obtained from the following surveys:

- AZ625 – Mohave County Area, AZ, Northeastern Part and Part of Coconino County (NRCS 2008). Soil survey coverage includes the western portion of the North Parcel.
- AZ629 – Coconino County Area, AZ, North Kaibab Part (NRCS 2009). Soil survey coverage includes the eastern portion of the North Parcel and the East Parcel.
- Kaibab National Forest TES (Brewer et al. 1991). Coverage of the TES includes all of the South Parcel, except for a few very small areas to which the survey may be reasonably extrapolated.

Generalized digital soil survey data were also obtained from the NRCS for generation of regional soils maps for the North and East parcels (NRCS 2006b). Generalized digital soil map data for the South Parcel were obtained from the Forest Service's Southwestern Region General Terrestrial Ecosystem Survey (GTES) data set (Forest Service 1998).

Soil mapping of the Northern Arizona region indicates that soil types are distributed in a repetitive pattern consistent with the topography, parent rock, and/or climatic setting across the proposed withdrawal area. Figure 3.5-1 presents the distribution of soils mapped at a scale of 1:250,000 in each area, grouped by soil association, or by soil group names for the TES, to represent the dominant occurring soil types. Figure 3.5-1 for the North and East parcels was developed using the general soils map for the United States (NRCS 2006b), modified using the detailed soil surveys (NRCS 2008, 2009). The GTES data were used to generate a soils map for the South Parcel (Forest Service 1998). Soil associations consist of several major soils and some minor soils but are named for major soils. The dominant soil associations or group names that occur in each parcel are summarized in Table 3.5-1 and described below. Detailed soil maps at a scale of 1:24,000 may be obtained for the parcels from the soil surveys and TES referenced above.

North Parcel

Twelve soil associations were identified in the North Parcel. The northwestern portion of the parcel is dominated by the Gypsiorthids-Grieta-Clayhole-Jocity and Pennell-Bacobi associations (see Figure 3.5-1). In general, the soils in these associations are well drained, shallow to deep, moderately coarse to moderately fine textured, nearly level to rolling and occur on sandstone and shale plateaus (NRCS 2008). The northeastern and southern portions of the parcel are dominated by the Mellenthin-Curhollow and Mellinthin-Poley-Moab-Rock Outcrop associations, respectively. These associations comprise well-drained, shallow, medium- to fine-textured, undulating to rolling soils on plains and plateaus (NRCS 2008, 2009).

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[2] Available at: <http://websoilsurvey.nrcs.usda.gov/app/>.

[3] Available at: <http://www.fs.fed.us/>.

Table 3.5-1. Area and Proportionate Extent of Soils

Parcel	Soil Association or Group Name	Approximate Area (acres)	Approximate Extent (%)
North	Mellinthin-Poley-Moab-Rock Outcrop	166,664	27.8
	Gypsiorthids-Grieta-Clayhole-Jocity	123,105	20.5
	Mellenthin-Curhollow	114,802	19.1
	Pennell-Bacobi	74,527	12.4
	Torriorthents-Rock Outcrop	27,169	4.5
	Yumtheska-Showlow-Lozinta-Goesling	25,835	4.3
	Kinan-Hatknoll-Grieta	22,374	3.7
	Yumtheska-Houserock	13,497	2.2
	Barx-Rock Outcrop	12,427	2.1
	Barx-Manikan-Palma-Bond-Bidonia	8,041	1.3
	Strych-Monue-Bison	6,564	1.1
	Torriorthents-Barx-Manikan-Mellenthin	5,171	0.9
	Subtotal	*600,171*	*100*
East	Pennell-Kinan-Jocity	56,261	38.8
	Curob-Monue-Bison-Clayhole-Strych	49,367	34.0
	Aneth-Torriorthents-Pagina-Wahweap	16,280	11.2
	Typic Haplustalfs-Rock Outcrop-Eutric Glossoboralfs	15,158	10.5
	Typic Haplustalfs	3,211	2.2
	Torriorthents-Rock Outcrop	3,161	2.2
	Mellenthin-Curhollow	1,510	1.0
	Other soils with minor representation	64	<1
	Subtotal	*145,011*	*100*
South	Lithic Ustochrepts	107,026	32.9
	Typic Eutroboralfs-Lithic Ustochrepts	85,744	26.3
	Lithic Ustochrepts-Fluventic Ustochrepts	81,480	25.0
	Lithic Ustochrepts-Typic Haplustalfs-Fluventic Ustochrepts	43,298	13.3
	Typic Eutroboralfs-Typic Haplustalfs-Typic Ustochrepts-Rock Outcrop	6,134	1.9
	Typic Haplustalfs-Typic Calciustolls	1,930	0.6
	Subtotal	*325,593*	*100*

Note: Parcel areas based on mapped withdrawal area boundary, including land where mineral rights are controlled by private entities.

East Parcel

The East Parcel is characterized by seven soil associations. The northwestern portion of the parcel is dominated by the Curob-Monue-Bison-Clayhole-Strych and Aneth-Torriorthents-Pagina-Wahweap associations (see Figure 3.5-1). Soils in these associations are generally well-drained, shallow to deep, moderately coarse to moderately fine textured, and nearly level to rolling (NRCS 2009). The southeastern portion of the parcel is dominated by the Pennell-Kinan-Jocity association. Soils in this association are generally well drained, shallow, medium to fine textured, and undulating to rolling and occur on plains and plateaus. Torriorthents-Rock Outcrop soils occur along the eastern edge of the parcel adjacent to

Marble Canyon; this association comprises well-drained, shallow to deep soils developed on 25% to 65% slopes from gypsiferous colluvium and/or alluvium derived from sedimentary rock.

South Parcel

Soils on the South Parcel are dominated by Typic, Lithic, and Fluventic Ustochrepts. The northeastern and northwestern portions of the parcel are dominated by Typic Ustochrepts (see Figure 3.5-1). These shallow to moderately deep, well-drained, gravelly, fine- to loamy-skeletal-textured soils occur on hills, ridges, plateaus and mesas, with slopes ranging from 0% to 120% (Brewer et al. 1991). The north-central portion of the parcel is dominated by Typic and Lithic Eutroboralfs. These moderately deep to deep well-drained, fine- to very fine-textured soils occur on hills, plateaus and benches, with slopes ranging from 5% to 40%. The southern portion of the parcel is dominated by Lithic Ustochrepts. These shallow, well-drained, gravelly and cobbly, loamy-skeletal-textured soils occur on flat to rolling terrain with slopes ranging from 0% to 15%.

3.5.4 Current Resource Conditions

This section describes the current conditions of soil resources in the proposed withdrawal area in terms of the resource indicators summarized earlier. These resource conditions are described in general terms relevant to the most likely impacts. Quantitative indicator values are presented where possible; otherwise, conditions are described qualitatively.

Existing Soil Disturbance

Construction activities, such as grading, excavation, and removal of vegetation and ground cover, related to the installation of support infrastructure for mining operations would inevitably result in soil disturbance. This disturbance would be expected to alter soil physical properties from compaction and/or displacement. Soil displacement could include loss of horizons, changes in thickness, and alteration of soil slope and drainage patterns. Disturbance from exploration activities would generally be less significant than disturbance associated with mining. According to the RFD scenarios, exploration activities do not usually require construction of access roads or drill sites. Disturbance would be expected to be limited to the area surrounding the drill sites but may include limited excavation for mud pits, site grading, and removal of vegetation. In addition, the drill rig and service vehicles would be expected to cause some soil compaction along off-road access routes and at the drill sites.

Review of mine reports submitted to ADEQ and the BLM indicates that previous mining activities in the North Parcel, including installation of access roads and utility lines, resulted in about 237 acres of total disturbance (Energy Fuels Nuclear, Inc. 1984, 1986, 1987, 1988a, 1988b). This is equivalent to an average surface disturbance of about 26 acres per mine for nine mine sites, including the Hack Canyon Mine (pre-1980s mine that produced mostly copper, silver, and manganese). In the South Parcel, approximately 17 acres of surface disturbance are associated with the Canyon Mine (Forest Service 1986a). According to information provided in the RFD scenarios, the total estimated area of historic disturbance related to exploration drilling is approximately 459 acres, or about 1.1 acres per exploration project. This estimate covers only the period during the peak of uranium mineral exploration and development between 1980 and 1988. The total amount of soil disturbance that has occurred to date is about 713 acres, of which roughly 603 acres have been reclaimed. The remaining 110 acres represent a very small fraction (0.011%) of the 1,006,545 acres proposed for withdrawal.

Existing Soil Erosion and Hazard Ratings

Increased rates of erosion, or soil loss, would be expected to occur following surface disturbance resulting primarily from increased runoff related to soil compaction, removal of vegetative cover, and re-routing of drainage pathways. Soil loss in undisturbed areas within the parcels is controlled by vegetative cover and soil physical characteristics, such as texture and topography (slope). Thus, rates of erosion vary, depending on site-specific conditions, but generally would be expected to be greatest where ground cover is minimal, soils are fine grained, and the surface slope is steep. Erosion hazard ratings for soils relate the physical properties and occurrence of different soils to the potential for increased soil loss under various uses, thus providing a useful tool in land management. Hazards related to the potential for accelerated erosion following land disturbance include hazards of off-road erosion, hazards of erosion on roads, and wind erodibility.

NORTH AND EAST PARCELS

Descriptions and data for soil properties related to increased erosion for the North and East parcels are drawn from the NRCS soil survey reports (NRCS 2008, 2009) and the National Soil Survey handbook (NRCS 2010).

- **Erosion Hazard from Off-Road Areas.** Soil loss potential from water action in off-road areas is determined from slope and soil erosion factor “K,” which is related to the susceptibility of a soil to sheet and rill erosion based on soil texture, organic matter content, soil structure, and saturated hydraulic conductivity (NRCS 2008, 2009). The soil loss is caused by sheet or rill erosion in areas without roads where 50% to 75% of the surface has been exposed by disturbance. Soil loss by water from other processes, such as gully erosion and mass wasting, are not considered. The hazard is classified as being slight, moderate, severe, or very severe. A rating of slight indicates that erosion is unlikely under ordinary climatic conditions. A rating of moderate indicates that some erosion is likely and that erosion-control measures may be needed. A rating of severe indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised. A rating of very severe indicates that significant erosion is expected, and erosion-control measures are costly and generally impractical.
    - **North Parcel.** The off-road erosion hazard is moderate to severe for the vast majority of soils in the North Parcel, which indicates that off-road erosion is likely under ordinary climatic conditions (personal communication, Robert Smith, BLM 2010a). Areas north of Snake Gulch and adjacent to the Kaibab National Forest are generally rated higher than the rest of the parcel. Soils within the canyon of Kanab Creek are not rated but would be expected to exhibit a moderate to severe off-road erosion hazard, depending on slope.
    - **East Parcel.** Most soils in the East Parcel are rated as having a moderate off-road erosion hazard, which indicates that erosion is likely under ordinary climatic conditions (personal communication, Robert Smith, BLM 2010a). Localized areas within the tributary washes of the Marble Canyon area have a higher off-road erosion hazard than most of the rest of the parcel (NRCS 2009).
- **Erosion Hazard from Unsurfaced Roads.** Soil loss potential due to water erosion from unsurfaced roadways is based on soil erosion factor K, slope, and content of rock fragments (NRCS 2008, 2009). The hazard is classified as being slight, moderate, or severe. A rating of slight indicates that little or no erosion is likely. A rating of moderate indicates that some erosion is likely, that the roads may require occasional maintenance, and that simple erosion-control measures are needed. A rating of severe indicates that significant erosion is expected, that the roads require frequent maintenance, and that costly erosion-control measures are needed.
    - **North Parcel.** Road erosion hazard ratings are generally moderate for soils in the North Parcel (personal communication, Robert Smith, BLM 2010a). There are localized areas

with a severe road erosion hazard rating in the northeastern portion of the parcel, adjacent to the Kaibab National Forest and southeast of the town of Fredonia (NRCS 2009).

- **East Parcel.** The road erosion hazard is moderate for the majority of soils in the East Parcel (personal communication, Robert Smith, BLM 2010a). In the eastern portion of the parcel along Marble Canyon, the hazard rating is severe, which indicates that significant erosion is expected under normal climatic conditions (NRCS 2009).

- **Wind Erodibility.** Soil loss from wind action is related to properties of surface layers, such as soil texture, organic matter content, rock and pararock fragment content, moisture content, and mineralogy, especially carbonate content (NRCS 2010). Soils are categorized based on the similarity of these properties as related to resistance of the soil to wind erosion in cultivated areas, also referred to as Wind Erodibility Groups (WEGs). Numeric estimates of susceptibility to wind erosion are assigned to each WEG, known as the Wind Erodibility Index (WEI). The WEI is expressed in tons per acre per year (tons/acre/year). WEG categories range from 1 to 8, with 8 indicating no susceptibility to wind erosion and 1 corresponding to a WEI of between 160 and 310 tons/acre/year. A soil in WEG category 5 has a WEI of 56 tons/acre/year.
  - **North Parcel.** WEG ratings in the North Parcel range from 5 to 8 in the southern and western portions of the parcel; local areas in the north central part of the parcel are category 3 (NRCS 2008). Ratings are 7 to 8 along the eastern margin of the North Parcel adjacent to the Kaibab National Forest; much of the remainder of the eastern portion is category 4, with local areas rated category 3 and 5.
  - **East Parcel.** The East Parcel is characterized by WEG ratings ranging from 5 to 8 along the southwestern margin of the parcel to ratings of 1 adjacent to Vermilion Cliffs (NRCS 2009). The central and northwestern portions of the parcel are rated between category 3 and 5. The eastern margin of the parcel is predominantly rated category 3; ratings of 6 occur locally.

SOUTH PARCEL

Descriptions and data for soil properties related to erosion for the South Parcel were obtained from the TES for the Kaibab National Forest (Brewer et al. 1991) and the TES handbook (Forest Service 1986b). These soil property descriptions are not directly analogous to the properties determined for NRCS soil surveys; however, some TES soil properties are applicable to erosion hazards in disturbed areas. The applicable soil properties are described as follows:

- **Erosion Hazard.** This property is similar to the NRCS Erosion Hazard from Off-Road Areas rating system. The TES erosion hazard is generally defined as the relative susceptibility to erosion following removal of vegetative cover and is based on soil loss from sheet/rill erosion as estimated by the Universal Soil Loss Equation (Brewer et al. 1991). Soil loss by water from other processes, such as gully erosion and mass wasting, are not considered. Soil losses are predicted for the four following categories: 1) the potential soil loss (PSL) is the rate of soil loss that would occur under conditions of complete removal of groundcover (i.e., maximum rate), 2) tolerance soil loss (TSL) is the highest rate of soil loss that can occur while sustaining inherent site productivity (i.e., threshold rate), 3) current loss is the rate of soil loss occurring under existing conditions of groundcover, and 4) natural loss is the rate of soil loss that would occur under conditions associated with a climax plant community (i.e., minimum rate).

  TES erosion hazard ratings are slight, moderate, and severe (Forest Service 1986b). A rating of slight is assigned where the PSL rate does not exceed the TSL rate. Degradation of soil productivity is of low probability, and areas within this erosion hazard class generally stabilize under natural conditions. Areas rated moderate exhibit PSL rates that exceed TSL rates, and loss of soil productivity is probable; reasonable and economically feasible mitigation measures are required to prevent significant losses in productivity. Severe hazard ratings are assigned to areas where PSL rates exceed TSL rates and where loss of productivity is inevitable. Areas with severe erosion hazards require significant mitigation measures to be applied to prevent irreversible loss in soil productivity, and there is a high probability of some productivity loss before mitigation can be applied.

  - **South Parcel.** Erosion hazard ratings range from slight to moderate for most of the parcel (Brewer et al. 1991). Significant areas rated moderate are located in the western, northwestern, and northeastern portions of the parcel. Severe ratings occur primarily along the Coconino Rim (Grandview Monocline, see Figure 3.4-13), the Red Butte area, and other steep areas in the northeastern part of the parcel. Severe ratings also occur locally in many small canyons throughout the parcel.

- **Unsurfaced Road Limitations.** Although the TES has no comparable measure to the NRCS road erosion hazard ratings, the TES unsurfaced road limitation property could be applied in a similar manner for the general analyses in this EIS. The TES unsurfaced road category pertains to the suitability for the use of native soils for unsurfaced roads in terms of construction and maintenance requirements (Brewer et al. 1991). These roads would be of low design and minimum construction cost (such as haul roads and for most exploratory drilling). A rating of slight indicates that there are few limitations or risks associated with unsurfaced roads. A rating of moderate or severe indicates that there would be problems in construction and maintenance of unsurfaced roads. Since most of these roads would be expected to receive little maintenance, alternative routes may be considered to avoid mitigation limitations and significant damage to soils rated moderate or severe.
  - **South Parcel.** Most soils in South Parcel are rated as having severe limitations for use as unsurfaced roads (Brewer et al. 1991). Localized areas, mostly valley floors, are rated moderate. The area at the base of the Coconino Rim in the northeastern part of the parcel is rated slight to moderate.

- **Wind Erodibility.** There is no soil property related to wind erosion defined in the TES. However, except in areas subject to severe wildfire damage, erosion from wind action is expected to be minimal throughout the parcel because of the significant level of vegetative cover present (personal communication, Christopher MacDonald, Forest Service 2010b).

Existing Soil Contamination

The chemical quality of soil and stream sediments in the vicinity of new uranium mine sites may be subject to alteration from the dispersal and subsequent deposition of uranium and other trace metals from mine waste and ore exposed to wind and water action at land surface. Containment of mine drainage in surface impoundments presents an additional risk to soil at mine sites in the event of liner failure. Uranium and, to a lesser extent, arsenic were identified as the most abundant trace elements of concern at the mine sites (Otton et al. 2010). ADEQ has established SRLs for soil in a non-residential setting (ADEQ 2007). SRLs were generally developed as risk-based screening criteria for the remediation of soils; the risk-based SRL for uranium is 200 ppm. The SRL for arsenic is 10 ppm, which is based on estimated background levels for Arizona rather than risk-based criteria.

This section evaluates available reports and data to establish regional and local (study area) background levels of uranium and arsenic in soil and sediment, as well as background concentrations associated with soils developed on uranium-bearing breccia pipes. To address current impacts on soil chemistry, the following summarizes the recent USGS study (Otton et al. 2010), which examined historic effects from mining in the North Parcel in detail.

NATURALLY OCCURRING CONCENTRATIONS OF URANIUM AND ARSENIC IN SOIL AND SEDIMENT

Otton et al. (2010) reviewed existing data and collected new analytical data from soil and sediment samples to determine background levels of uranium and trace metals for the study area. Geochemical data obtained from the National Uranium Resource Evaluation (NURE) database were analyzed for the twelve 7.5-minute quadrangles surrounding the mine sites in the North Parcel to determine background levels for uranium. The NURE samples in this area were collected in 1979, prior to the majority of mining activities in the North Parcel (Otton et al. 2010). This analysis indicated that samples from undisturbed soil in the study area contained uranium ranging from 1.4 to 3.4 ppm, with an average of 2.4 ppm (106 samples). No arsenic results were available from NURE. Otton et al. (2010) collected nine samples of stream alluvium from the nearby unmined, unmineralized Jumpup Canyon to determine background levels for the study area in stream sediments. The results of these stream sediment analyses were as follows: uranium ranged from 1.6 to 1.9 ppm and averaged 1.7 ppm; arsenic ranged from 4 to 5 ppm and averaged 4.6 ppm.

A regional survey was conducted by the USGS from 1961 to 1975 across the conterminous United States to determine the elemental concentrations present in unaltered surficial material and soil (Shacklette and Boerngen 1984). The samples analyzed for this survey were collected from a depth of 20 cm (or about 8 inches). For the Western United States, concentrations reported by Shacklette and Boerngen (1984) for uranium ranged from 0.68 to 7.9 ppm and averaged 2.5 ppm; concentrations for arsenic ranged from <0.10 to 97 ppm and averaged 5.5 ppm. These regional average values are generally consistent with the results from Otton et al. (2010) for average uranium content of soils samples in the study area (i.e., 2.4 ppm). The slightly higher regional arsenic estimate reported by Shacklette and Boerngen (1984) could be because of the small sample size, small area, or difference in media (sediment rather than soil) of the Otton et al. (2010) sample set obtained from Jumpup Canyon.

The results for soil and alluvium background concentrations by Otton et al. (2010) are consistent with an earlier USGS study conducted in the Snake Gulch area prior to development of the Pigeon Mine (Hopkins et al. 1984b). The Hopkins et al. (1984b) survey showed that uranium ranged from 0.4 to 1.4 ppm for soils (six samples) and from 0.2 to 2.0 ppm for sediment (31 samples) in the Snake Gulch area. Arsenic results for all samples analyzed by Hopkins et al. (1984b) were below the detection limit of 200 ppm. Another study conducted in 1999 investigated the geochemical impact on sediments in Hack Canyon from the mining activities at the Hack Canyon Mine complex: sediment samples obtained upstream of the Hack Canyon Mine complex contained uranium ranging from 0.6 to 1.5 ppm and arsenic ranging from 1.2 to 11.5 ppm (Carver 1999).

In addition to the study area and regional background concentrations described in the previous paragraphs, Otton et al. (2010) also reviewed available results for samples obtained across the surface expression of known mineralized breccia pipes. Hopkins et al. (1984b) obtained three soil samples from the surface of the Pigeon Pipe prior to initiation of mining: uranium ranged from 2.2 to 5.6 ppm, and arsenic was below the detection limit of 200 ppm for these samples. The Canyon Pipe, located in the South Parcel, was surveyed by Van Gosen and Wenrich (1991) prior to development of the site for mining. The investigation of the Canyon Pipe surface expression conducted by Van Gosen and Wenrich (1991) consisted of 14 soil samples outside the perimeter of the pipe and 18 soil samples within the pipe surface. Results indicated that uranium and arsenic concentrations are similar, regardless of whether samples were obtained within or beyond the pipe surface expression. The Canyon Pipe soil sample results are as follows: uranium concentrations ranged from 2.6 to 4.3 ppm, with an average of 3.2 ppm; arsenic concentrations ranged from less than 10 to 20 ppm, with an average of less than 10 ppm. Van Gosen and Wenrich (1991) investigated another mineralized breccia pipe, the SBF Pipe, located adjacent to the Hualapai Reservation, about 45 miles southwest of the Canyon Pipe. The surface expression of the SBF Pipe is characterized by a 7-foot-high rim consisting of Kaibab Formation encompassing a soil-filled, circular basin floored by Moenkopi Formation sandstone and siltstone. Similar geological conditions occur for other pipes located on the Coconino and Kaibab plateaus and for pipes on much of the Kanab Plateau (see Figures 3.4-5 and 3.4-8). Results from the SBF Pipe indicated that, although there was little difference in soil uranium concentrations inside and outside the pipe surface area, arsenic concentrations were much higher within the pipe area. Average uranium concentrations for the SBF Pipe were about 2.9 ppm inside the pipe surface area (20 samples) and about 2.6 ppm outside the pipe (16 samples); maximum uranium concentration detected was 3.7 ppm and was for a sample from inside the surface area of the pipe. Arsenic concentrations within the SBF Pipe surface area ranged from 10 to 110 ppm; average concentration was 33 ppm. Arsenic concentrations outside the pipe ranged from 4.2 to 32 ppm; average concentration was 12 ppm (Van Gosen and Wenrich 1991).

The regional survey of undisturbed soil reported by Shacklette and Boerngen (1984) provides a reasonable approximation of overall ambient conditions and is generally consistent with the analysis of conditions in the study area presented by Otton et al. (2010). However, naturally occurring levels of uranium and arsenic in the vicinity of specific uranium-bearing breccia pipes are likely to vary from site to site because of variability in surface rock compositions and environmental conditions (reduction-oxidation potential). Site-specific concentrations may be lower or higher than the regional levels reported by (Shacklette and Boerngen 1984). This conclusion is supported by the somewhat variable sample results for undisturbed soils at the Pigeon, Canyon, and SBF pipes (Hopkins et al. 1984b; Van Gosen and Wenrich 1991) and by results for sediment samples obtained upstream of the Hack Canyon mines (mineralized, unmined area) and Jumpup Canyon (unmineralized, unmined area) (Carver 1999; Otton et al. 2010). Thus, concentrations of contaminants of concern at specific sites should be considered in light of both average and maximum naturally occurring concentrations when evaluating the magnitude of a potential impact. The range and average naturally occurring concentrations for the primary constituents of concern are listed in Table 3.5-2. Ideally, background conditions and their variability at each mine site prior to initiation of mining should be known to infer that an impact has likely occurred. However, in many cases described in the next section, impacts can be inferred without pre-mining data because concentrations of contaminants of concern are well above background levels and approximated background conditions at unmined sites in the study area.

Table 3.5-2. Concentrations of Naturally Occurring Uranium and Arsenic in Undisturbed Soil and Sediment

	Regional Range (ppm)*	Regional Average (ppm)*	Breccia Pipe Range (ppm)†
Uranium	0.68–7.9	2.5	2.2–5.6
Arsenic	<0.10–97	5.5	4.2–110

Note: ppm = parts per million.

* From Shacklette and Boerngen (1984) for the western United States; values reported as geometric means.

† Range of sample results at unmined uranium-bearing breccia pipes. Source for uranium range is Hopkins et al. (1984b). Source for arsenic is Van Gosen and Wenrich (1991).

EFFECTS FROM HISTORIC (1980s) MINING

A study of existing mine sites in the North Parcel was conducted by the USGS in 2009 to characterize current impacts of historic uranium mining activities on soil and sediment near former and inactive mine and exploration sites (Otton et al. 2010). Reclaimed mine sites, including Pigeon Mine, the Hack Canyon Mine complex, and Hermit Mine, and the inactive Kanab North Mine, were evaluated for the study. The Kanab South Pipe drill site was also investigated. Assessment included sampling and geochemical analysis of surface soils, stream sediments, rock, and mine wastes for uranium and trace elements. Samples were generally taken inside and outside reclaimed/disturbed areas; most samples were collected within about 500 feet of the reclaimed areas. All samples were obtained from a depth of 0 to 2 inches; the study did not include investigation of subsurface materials, such as mine waste or drill cuttings potentially buried during reclamation.

In addition to the soil and sediment samples collected for the USGS study, radioactivity surveys were conducted at each site, including measurements at each sample location and at some unsampled areas (Otton et al. 2010). These surveys were conducted using Ludlum Model 19 MicroR exposure meters. MicroR meters measure radiation exposure from gamma-ray and x-ray emissions. MicroR measurements are reported in microrads per hour (μR/h).

Findings of Otton et al. (2010) are summarized as follows.

- **Pigeon Mine.** The Pigeon Mine was operational for 5 years and was reclaimed in 1989. The mine facilities consisted of the mine site (at the pipe), operations site, and wastewater surface impoundment. The operations and impoundment sites were both located about 1,000 feet northwest of the mine site. In 26 soil samples collected inside the reclaimed mine site area, median uranium concentration was 4.4 ppm, and median arsenic concentration was 41 ppm (Table 3.5-3). These results are believed to represent cover materials used to reclaim the site. Two samples obtained within the reclaimed area were much higher in uranium (68 and 79.1 ppm) and arsenic (377 and 407 ppm). These two samples were believed to represent soil impacted by exposed waste rock, hence the reporting of median results for this site rather than the numeric averages reported for the other sites investigated. Excluding these two anomalously high soil sample results, uranium concentrations within the reclaimed area ranged from 2.2 to 8.1 ppm, and arsenic concentrations ranged from 6 to 93 ppm.

  Of 16 soil samples collected within about 500 feet beyond the reclaimed area, the median uranium concentration detected was 6.3 ppm, and the median arsenic concentration was 25 ppm (see Table 3.5-3). Concentrations detected for two samples obtained on a hillslope about 200 feet northeast from the disturbed area were 26.5 and 36.6 ppm for uranium and 62 and 66 ppm for arsenic. These anomalously high sample results were thought to possibly be the result of off-site dispersion of mine-waste constituents from wind erosion. Concentrations detected for a third sample collected on a hillslope southeast of the reclaimed area were 11.1 ppm for uranium and 393 ppm for arsenic. Both wind-dispersed mine waste rock and weakly mineralized limonite-cemented sandstone (parent material) in the area may be the source of these elevated concentrations. Excluding the three anomalously high concentrations, uranium concentrations for soil samples collected outside the reclaimed area ranged from 3.2 to 12.9 ppm, and arsenic concentrations ranged from 7 to 46 ppm. Uranium levels in the five samples collected farthest from the site, about 500 feet or more north, northeast, and northwest of the site, ranged from 3.2 to 10.6 ppm (average 5.1 ppm); arsenic levels detected in these five samples ranged from 10 to 31 ppm (average 23 ppm) (see Table 3.5-3).

  Ephemeral stream sediment samples obtained downstream of the reclaimed Pigeon Mine appear to be slightly elevated in uranium and arsenic, compared with samples obtained upstream of the site. The source of these elevated concentrations may be distribution of mine-related contaminants and/or mineralized bedrock in the area.

  The average concentration of 15 soil samples obtained in the vicinity of the operations area was about 11.9 ppm for uranium and about 29 ppm for arsenic (excluding one anomalously high sample result with a uranium concentration of 206 ppm, and an arsenic concentration of 455 ppm). Several isolated deposits of mine waste remaining on-site, primarily in the operations area, were sampled; uranium concentrations as high as 1,230 ppm and arsenic concentrations as high as 1,980 ppm were detected in these samples.

  Otton et al. (2010) concluded that some soils at the Pigeon Mine reclaimed site are impacted to levels above cited background averages by off-site dispersion of trace elements in dust and by transport, via slope wash, of constituents related to exposed waste-rock fragments within the reclaimed area.

Table 3.5-3. Summary of Soil and Sediment Sample Results from Mines

	Pigeon (reclaimed)	Kanab North (unreclaimed)	Hermit (reclaimed)	Hack Canyon[‡] (reclaimed)
Inside Mine Site				
Number of Samples	26	13	22	N/A
Uranium, Range of Results (ppm)*	2.2–8.1	6.4–2,840	1.6–19.9	N/A
Uranium, Average of Results (ppm)[†]	4.4	1,135	4.6	N/A
Uranium, Outliers (ppm)	68 and 79.1	N/A	N/A	N/A
Arsenic, Range of Results (ppm)*	6–93	4–1,980	4–27	N/A
Arsenic, Average of Results (ppm)[†]	41	380	8	N/A
Arsenic, Outliers (ppm)	377 and 407	N/A	N/A	N/A
Outside Mine Site				**(up to 0.8 mile downstream)**
Number of Samples	16	22	35	4
Uranium, Range of Results (ppm)*	3.2–12.9	2.9–80.2	1.1–5.9	4.8–10.2
Uranium, Average of Results (ppm)[†]	6.3	27.8	1.9	6.6
Uranium, Outliers (ppm)	26.5 and 36.6	N/A	N/A	N/A
Arsenic, Range of Results (ppm)*	7–46	3–27	3–10	10–17
Arsenic, Average of Results (ppm)[†]	25	12	5	13
Arsenic, Outliers (ppm)	62, 66, and 393	N/A	N/A	N/A
Approximate Distance of Farthest Samples	≥ 500 feet	300 and 420 feet	≥ 325 feet	1.6 and 4.0 miles
Uranium Concentration of Farthest Samples (ppm)	3.2–10.6	10.3 and 6.9	1.2–1.9	3.2 and 2.4
Arsenic Concentration of Farthest Samples (ppm)	10–31	9 and 8	3–5	11 and 9

Source: Otton et al. (2010). Results for Pigeon Mine are for the mine site only, as summarized in Otton et al (2010); see text for discussion of sample results from the operations area.

Note: ppm = parts per million; N/A = not applicable.

* Excluding outliers at Pigeon Mine.

[†] Median values reported for Pigeon Mine; includes outliers.

[‡] Sediment samples. Concentrations detected in four sediment samples collected upstream from the Hack Canyon mines ranged from 2.1 to 3.9 ppm for uranium (2.9 ppm average) and ranged from 10 to 14 ppm for arsenic (12 ppm average).

- **Kanab North Mine.** Extraction of ore at the Kanab North Mine occurred between 1988 and 1990; the mine has been under interim management since 1992. The Kanab North Mine consists of a single fully bermed (except at the main gate) surface facility; the facility houses the mine access, management offices, a lined wastewater surface impoundment, and waste and ore stockpiling areas. The site is situated about 150 feet (closest edge) west from the edge of the canyon of Kanab Creek, which is approximately 1,200 feet below the plateau surface at this location. Mined waste rock and uranium ore have been exposed at the surface of the unreclaimed mine site for the duration of the interim management period. Investigation of the Kanab North Mine included sampling within the mine perimeter for disturbed soil, graded surfaces, and sediment in the surface impoundment, as well as undisturbed soils adjacent to the site. Results for 13 samples obtained within the mine site indicated that uranium concentrations ranged from 6.4 to 2,840 ppm (average 1,135 ppm), and arsenic concentrations ranged from 4 to 1,980 ppm (average 380 ppm) (see Table 3.5-3).

Results for 22 soil samples obtained up to 420 feet outside the mine site perimeter indicated that uranium concentrations ranged from 2.9 to 80.2 ppm (average 27.8 ppm), and arsenic concentrations ranged from 3 to 27 ppm (average was 12 ppm) (see Table 3.5-3). These samples were generally collected within about 250 feet of the site perimeter; two of these samples were collected about 300 and 420 feet northwest of the site. Uranium concentrations detected in these two farthest samples were 10.3 and 6.9 ppm, respectively; arsenic concentrations were 9 and 8 ppm, respectively (see Table 3.5-3). Results of the samples taken outside the perimeter indicate that concentrations are greatest to the east from the site, which is likely the prevailing wind direction. Thus, wind is believed to be the likely transport mechanism of constituent dispersion outside the site perimeter. On the basis that only one sample collected outside the site approximated the NURE uranium background average of 2.4 ppm, Otton et al. (2010) further concluded that mine-related materials may have dispersed beyond the limit of sampling (420 feet). It is unlikely that waterborne sediment migrated off-site because the containment berm surrounding the site was intact when the Otton et al. (2010) investigation was conducted in 2009.

- **Kanab South Pipe.** The Kanab South Pipe is located about 3,700 feet south of the Kanab North Mine. Erosion of the pipe surface has led to widening of a small wash that crosses the pipe surface and enters the canyon of Kanab Creek about 500 feet to the northeast. Six soil samples were obtained from low hills adjacent to the disturbed drill site area; concentrations detected in these samples ranged from 1.3 to 2.7 ppm for uranium and from 5 to 23 ppm for arsenic. Stream sediment samples were also collected upstream of and on the site; concentrations detected in these six samples ranged from 1.5 to 3.6 ppm for uranium and from 4 to 20 ppm for arsenic. Limonite-cemented sandstone bedrock occurring along the drainage pathway upstream of the site was also sampled; the results indicate that bedrock in the area may contain up to 54.9 ppm of uranium and 896 ppm of arsenic. Genetically similar sandstones were noted at the Pigeon Mine site; it was postulated that such mineralized zones in these sandstones may have formed by fluids circulating near the pipes during deposition of uranium ore. Results for soil and sediment samples at the Kanab South Pipe were thought to possibly represent background conditions at the Kanab North Mine because physiographic and geological conditions are similar.

- **Hermit Mine.** The Hermit Mine was operational for less than 1 year and was reclaimed in 1989. The Hermit Mine had a single surface facility with components that were similar to the Kanab North Mine. The mine was located in a relatively flat area about 8 miles west of the Kanab North Mine; surface water drainage at the site appears to flow to the north into a small stock tank. Concentrations of uranium in 22 soil samples collected within the reclaimed area ranged from 1.6 to 19.9 ppm (average 4.6 ppm), and arsenic concentrations ranged from 4 to 27 ppm (average 8 ppm) (see Table 3.5-3). Concentrations of uranium in 35 soil samples collected outside the reclaimed area ranged from 1.1 to 5.9 ppm (average 1.9 ppm), and arsenic concentrations ranged from 3 to 10 ppm (average 5 ppm) (see Table 3.5-3). All arsenic samples with concentrations greater than 6 ppm were obtained in the reclaimed area, the access road, and the stock tank. Otton et al. (2010) concluded that limited off-site dispersion of mine-related constituents had occurred at the Hermit Mine. Uranium and trace element concentrations in soil were determined to be at or below the background levels cited by Otton et al. (2010) within a few hundred feet outside the reclaimed edge of the Hermit Mine site.

- **Hack Canyon Mine Complex.** The Hack Canyon Mine complex includes the Hack Canyon Mine, which was operational for uranium production in the 1950s and 1960s, and Hack Canyon Mines 1, 2, and 3, which operated from 1981 to 1987. The first Hack Canyon Mine was developed for copper in the 1920s (Energy Fuels Nuclear, Inc. 1988b). Reclamation of all four Hack Canyon mines was completed in 1988. During mine operations, a significant flood event occurred on August 19, 1984, in the tributary that was occupied by Hack 1; radioactive materials were reported to have been recovered by mine personnel up to 1 mile downstream following the flood. All four of these mines were situated in canyon bottoms—either Robinson Canyon (Hack

3), an unnamed tributary canyon (Hack 1), or Hack Canyon Mine itself (Hack Canyon and Hack 2 mines). A total of 10 ephemeral stream sediment samples were obtained during the investigations. Four of these samples were obtained upstream of the mine sites, one sample was collected between Hack 2 and Hack 1, and five samples were obtained downstream of the mine sites. Concentrations detected in all stream sediment samples ranged between 2.1 and 10.2 ppm for uranium and between 9 and 17 ppm for arsenic. The upstream samples, which were said to represent background conditions for this area, ranged from 2.1 to 3.9 ppm for uranium (2.9 ppm average) and from 10 to 14 ppm for arsenic (12 ppm average). Concentrations of trace elements in the stream samples obtained about 2 to 3 miles downstream of the Hack Canyon Mine complex were determined to be about the same as those upstream of the complex; this result is consistent with conclusions made by Carver (1999) that “mean concentrations above the mine are equal to the mean concentrations below the mine.” Uranium concentration detected in a sediment sample collected several miles downstream, near Willow Spring, was 2.4 ppm.

Flood events were determined to be the likely transport mechanism for several isolated fragments of mineralized rock, believed to be mine waste, found up to 0.5 mile downstream of the reclaimed sites by Otton et al. (2010). The rock fragments ranged between 2 and 18 inches in diameter. Five of the fragments were sampled, and analyses detected uranium concentrations ranging from 122 ppm to greater than 10,000 ppm, and arsenic concentrations ranging from 547 ppm to greater than 10,000 ppm. The presence of these fragments was attributed to flood events that transported waste rock off-site during mining or that eroded cover material in reclaimed areas, exposing and transporting buried mine wastes off-site after reclamation. The source of many of these fragments was believed to be the reclaimed terrace near Hack 1, which consists of several feet of waste rock covered by gravel that has been eroded by the ephemeral stream to expose the deposits. Although discrete fragments of rock containing large concentrations of mine-related constituents were identified by Otton et al. (2010), much lower concentrations of constituents were detected in fine-grained sediments (discussed in the previous paragraph), which shows limited dispersion of contaminants downstream. It was concluded that mine-derived particulates in stream sediments are diluted by large quantities of native fine-grained sediments during flooding, thus limiting the effects of these contaminants on the overall chemical quality of the sediment.

- **MicroR Meter Surveys.** The radioactivity surveys conducted indicated that radiation exposure detected at all of the sites was elevated, compared with readings obtained from the Jumpup Canyon area. The survey of the Jumpup Canyon area showed a narrow range of activity from 4 to 5 microrads per hour (μR/hr). The highest readings were obtained at the Kanab North Mine, followed by the Pigeon Mine and then the Hack Canyon mines. Radiation levels decreased rapidly within 400 feet of the Kanab North Mine perimeter. At the Pigeon and Hack Canyon mines, field surveying indicated that radioactivity decreased significantly within a few feet of the anomalous point sources, such as isolated ore and waste-rock fragments. Considerably lower levels of radiation were detected at the Hermit Mine. During traverses beyond the disturbed area at the Hermit site, activity levels generally ranged from 6 to 7 μR/hr (with a maximum value of 10 μR/hr). The traverses at the Hermit site were all at least 250 feet long. Results at the Kanab South site were considered by Otton et al (2010) to potentially be indicative of background conditions for the Kanab North Mine; these results showed a range of activity levels from 3 to 7 μR/hr.

Soil and sediment analyses conducted by Otton et al. (2010) detected uranium concentrations at all of the reclaimed, inactive (unreclaimed) mine sites that ranged from below regional average levels to above regional average levels (see Table 3.5-2). The degree to which soil is affected at each mine site varies, based on physiographic setting, the length of time mine rock was exposed at the surface, and the effectiveness of reclamation efforts. The effects from historic mining discussed above reflect the reclamation practices that were conducted under the regulatory framework that existed during the 1980s. Reclamation activities undertaken at that time may differ from the reclamation activities reasonably foreseen to be implemented under current requirements related to future plans of operation but are anticipated to be generally comparable. This is particularly true with respect to the later mines, such as Hermit and Pigeon, that were reclaimed near the end of the period of mining in the 1980s. Expected reclamation techniques, including those for long- or short-term interim management, are discussed in Section 4.5.2.

Salient conclusions made for this EIS regarding the potential distribution and accumulation of mine-related contaminants in soil and alluvium are as follows:

- Assessment of existing mine sites by Otton et al. (2010) indicates that significant changes in soil conditions as a result of past uranium mining are generally localized to within a few hundred feet of the areas of operation, except where mine sites may be subject to significant flash flooding (Hack Canyon mines). Soil samples collected 500 feet or more from the reclaimed area at the Pigeon Mine averaged 5.1 ppm for uranium and 23 ppm for arsenic, which are 2.5 and 17.5 ppm above the respective regional averages listed in Table 3.5-2 but are generally within the upper range of naturally occurring concentrations for uranium (5.6 ppm) and arsenic (110 ppm) associated with unmined uranium-bearing breccia pipes. Similarly, the farthest two samples collected about 300 and 420 feet from the Kanab North site contained uranium concentrations of 10.3 and 6.9 ppm, which are respectively about 5 and 1 ppm above the high end of the range of estimates for naturally occurring uranium (see Table 3.5-2). Results from the Hermit Mine site, which was more compact and operated for a much shorter duration than the Pigeon Mine, indicate that concentrations of mine-related constituents are generally at or below regional averages about 100 feet beyond the reclaimed area. The primary mechanism of off-site dispersion of mine-related constituents at sites removed from major drainage channels is fugitive dust generated at ore and waste-rock stockpiles during mining operations; a potential, but limited, secondary mechanism is slope wash transport of exposed waste materials remaining on-site after reclamation. This potential secondary mechanism is supported by a few samples collected at the Pigeon Mine site; however, there is little evidence of significant off-site movement of contaminants from slope wash.

  Where mine sites are located within drainage channels subject to flash flooding or are adjacent to steep areas or canyons, mine-related constituents have the potential to be dispersed more than a few hundred feet from the mine site. Evidence collected at the Hack Canyon Mine complex indicates that waste materials have been transported up to 0.5 mile downstream from the sites. Some of these ore/waste-rock deposits observed downstream of the Hack Canyon Mine complex could be the result of mining activities at the Hack Canyon Mine, rather than 1980s-era mining. Although trace element concentrations may be very high in mine waste fragments displaced by flooding, evidence collected by Otton et al. (2010) and Carver (1999) indicates that the overall impact to the fine-grained stream sediments is limited. An example of a mine site located adjacent to steep topography is provided by the Kanab North Mine. Samples collected within about 200 feet northeast from the Kanab North site perimeter contained up to 77.7 ppm more than the regional average background concentration for uranium (see Table 3.5-2). These samples were obtained in the prevailing downwind direction and immediately adjacent to the canyon of Kanab Creek, which suggests that mine-related contaminants may have dispersed off-site into the canyon. The total potential distance that sediment could be transported would be larger for a mine adjacent to a canyon, compared with a mine located away from a canyon, because particles would be expected to maintain their trajectory longer as they descend into the canyon. Similarly, waterborne sediments that enter a canyon or other steep area have the potential to move farther away from their source than sediments that remain in relatively level areas.

- Duration and scale of mining operations directly correlate to the magnitude and extent of contamination (e.g., compare Pigeon Mine effects with Hermit Mine effects). The area outside mine sites at reclaimed mines are also generally less impacted (at present)–than mine sites under very long-term interim management.

- This investigation was conducted at least 20 years after completion of reclamation efforts at the mines and about 20 years after the Kanab North Mine was deactivated. At reclaimed mines where significant amounts of erosion have not occurred, such as the Hermit Mine, surface conditions reported in Otton et al. (2010) are likely similar to conditions immediately after reclamation was completed. At mine sites where erosion may have exposed buried mine waste, such as the Hack Canyon mines, recently observed concentrations may be lower than conditions that may have existed immediately following the first significant erosive event, which would have removed cover materials, eroded buried waste, and re-deposited waste immediately downstream.
  This could occur because subsequent events may have dispersed contaminants to the extent that they were not detectable or diluted them to the levels observed in Otton et al. (2010). Effects on soils at inactive mines, such as Kanab North, are likely to be at their greatest because continual wind dispersion of materials off-site would be expected to generate a cumulative effect on the chemistry of downwind surface soils (assuming the soils themselves have not been subject to significant erosion).
- In general, Otton et al. (2010) compared average sample results at given sites with average regional background concentrations, which may not be appropriate for all locations because natural conditions may vary from site to site. Given that most samples were collected within a few hundred feet of reclaimed areas, particularly at the Kanab North Mine, the areal extent of sample collection may not have been large enough to clearly establish site-specific background conditions or the range of concentrations for naturally occurring elements present in the vicinity of the site. Thus, some comparisons presented by Otton et al. (2010) may over estimate or under estimate actual impacts.
- In some cases, particularly the Pigeon and Kanab North mines, samples collected outside reclaimed or disturbed areas may represent variability in natural conditions for the specific site, rather than elevated concentrations of trace elements as a result of mining activities. For example, mineralized bedrock noted at some sites (Pigeon Mine and Kanab South Pipe), which could be the parent materials for soil or source material for alluvium, may contribute to the apparently elevated concentrations of uranium and arsenic measured near mine sites in the area.
- Uranium concentrations reported in soil samples collected at all sites ranged from below to above the average regional background concentration (2.5 ppm); however, the concentrations were generally below the ADEQ non-residential SRL of 200 ppm.
- The arsenic non-residential SRL of 10 ppm was exceeded in many samples at each site. Because the arsenic SRL is based on background levels, 10 ppm may not be appropriate for all sites; arsenic concentrations in soils were generally below the maximum reported concentration in an undisturbed mineralized pipe (110 ppm at the SBF Pipe) but were generally above the average regional background of 5.5 ppm.
- Isolated waste-rock and ore fragments that contain significantly elevated levels of uranium and arsenic were identified at the Pigeon Mine and in the vicinity of the Hack Canyon Mine complex. Such fragments could contribute to localized contamination of soils in the immediate vicinity of the fragments as a result of leaching processes.
- The primary mechanism for dispersion of mine-related contaminants appears to be wind erosion of waste-rock and ore stockpiles during mining operations. A secondary mechanism for dispersion is water erosion of cover materials and buried waste rock after reclamation. Waste materials exposed by erosion of cover materials might result in minor contaminant dispersion by wind. Also, for mines located in large drainage channels or canyons, floods could disperse mine-related constituents from stockpiles during operations.

- The potential effect on subsurface soils (greater than 2 inches deep) is not known. Leaching of buried mine wastes could result in accumulation of contaminants in materials beneath or downslope of such mine-waste deposits. Although such impacts are conceivable, if cover materials remain intact, leaching from buried mine waste would be expected to be minimal.

3.6 VEGETATION RESOURCES

The Colorado Plateau ecoregion contains diverse flora and fauna. The isolation, complex geological features, and substantial climate change from glacial to postglacial times have led to the existence of many relict populations of endemic species that are exclusively native to this region. More than 300 plant species are endemic to the Colorado Plateau (Tuhy et al. 2002), and the Colorado Plateau provides habitat for numerous vertebrates, many of which are identified as “species of greatest conservation need” by the Southwest Regional Gap Analysis Project (Boykin et al. 2007). Several plant species are listed as federally protected species and are discussed in more detail in Section 3.8. Additionally, there are ACECs within and near the proposed withdrawal area, some of which were designated to protect threatened plant species (see Section 3.1.2), shown in Figure 3.6-1.

3.6.1 Vegetation Communities

The Colorado Plateau ecoregion contains a variety of vegetation communities. In the proposed withdrawal area, the communities include riparian, Great Basin Grassland, Great Basin Desertscrub, Great Basin Conifer Woodland, and Petran Montane Conifer Forest. Table 3.6-1 lists dominant plant species for each of these eight communities. Figure 3.6-2 illustrates the distribution of these major vegetation types. Digital representation of these communities was developed by the Nature Conservancy in Arizona based on the map “Biotic Communities of the Southwest” by Brown and Lowe (1980) in order to provide for easier interagency discussion of the vegetation types. These areas have been mapped in more detail as “ecological zones” in the Arizona Strip FEIS (BLM 2007). Detailed community descriptions of the vegetation communities found in the proposed withdrawal area are based on BLM (2008b) and Forest Service (2009a), unless indicated otherwise.

Table 3.6-1. Vegetation Communities and Dominant Plant Species on the Colorado Plateau within the Proposed Withdrawal Analysis Area

Vegetation Community	Dominant Plant Species
Riparian	Cottonwood (*Populus* spp.), willow (*Salix* spp.), saltcedar (*Tamarix* spp.)
Great Basin Grassland	Grasses, including wheatgrass (*Pascopyrum smithii*), grama (*Bouteloua* spp.), galleta (*Pleuraphis jamesii*), three-awn (*Aristida* spp.), muhly (*Muhlenbergia* spp.), needlegrass (*Achnatherum* spp.), fescue (*Festuca* spp.), dropseed (*Sporobolus* spp.)
Great Basin Desertscrub	Sagebrush (*Artemesia* spp.), shadscale (*Atriplex confertifolid*), saltbush (*Atriplex* spp.), winterfat (*Krascheninnikovia lanata*), blackbrush (*Coleogyne ramosissima*), greasewood (*Sarcobatus vermiculatus*)
Great Basin Conifer Woodland	Pinyon pine (*Pinus* spp.), juniper (*Juniperus* spp.)
Petran Montane Conifer Forest	Ponderosa pine (*Pinus ponderosa*), Gambel oak (*Quercus gambelii*)

Sources: BLM (2008b, 2010e).

Riparian

The only major riparian vegetation community in the proposed withdrawal area occurs along Kanab Creek in the North Parcel. In the vicinity of the proposed withdrawal area, riparian communities are associated with surface water habitats such as rivers, streams, seeps, and springs, primarily along the Colorado River and its many side canyons and include resources such as Vasey's Paradise. At seeps and springs, natural conditions may include small wetland and/or riparian zones along short reaches of the drainages in which the springs and seeps occur. Riparian areas are a transition between permanently saturated areas and upland areas with visible vegetation or physical characteristics reflective of permanent surface or subsurface water influence. Native riparian vegetation in these areas includes cottonwood (*Populus* spp.), willow (*Salix* spp.), seep willow (*Baccharis salicifolia*), arrowweed (*Pluchea sericea*), ash (*Fraxinus* spp.), cattail (*Typha* spp.), rush (*Juncus* spp.), and sedge (*Carex* spp.), as well as a variety of grasses and forbs (BLM 2008b). However, in many of the riparian areas, including Kanab Creek and associated side canyons, native vegetation is being displaced by invasive species such as saltcedar (*Tamarix* spp.). Saltcedar is now a dominant riparian shrubby tree in the Colorado River basin below 6,000 feet amsl. Kanab Creek also hosts populations of tree of heaven (*Ailanthus altissima*) and pampus grass (*Cortaderia* sp.). Other nonnative species occurring in these riparian communities are Russian olive (*Elaeagnus angustifolia*), rabbit foot grass (*Polypogon monspeliensis*), dallisgrass (*Paspalum dilatatum*), Bermuda grass (*Cynodon dactylon*), cocklebur (*Xanthium* spp.), and thistles (Family Asteraceae) (BLM 2007). Brome grasses (*Bromus* spp.) and knapweeds (*Centaurea* spp.) are also common.

Human diversion or impoundment of free-flowing water by dams, diversions, irrigation, or channelization has been a major factor in the degradation of the natural functions of riparian areas on the Colorado Plateau (BLM 2008b). Without natural hydrologic systems, water tables have lowered, and surface sediments have dried out. Cottonwood and willow are particularly susceptible to water stress and may decline as groundwater becomes less available. With less flooding, there is less channel shifting and less suitable habitat for cottonwood and willow seedlings, which are dependent on recently inundated sediments to become established. Historically, fire was probably uncommon in this vegetation community (BLM 2008b). However, flammable fuel loads have increased dramatically in riparian areas because of drought, limited flooding that ordinarily would remove litter and woody debris, and dense buildup of saltcedar, which is highly flammable.

Great Basin Grassland

Portions of the North and South parcels contain Great Basin Grassland vegetation communities that extend beyond the boundaries of this study. These grasslands occur on nearly level, wind-desiccated geomorphic surfaces of sedimentary and igneous origin. There are few trees in the ecological zone, consisting mostly of scattered pinyon and juniper. Occasionally, cacti or shrubs may also be present, usually along the edge of the grassland or in microhabitats. Dominant grass species include western wheatgrass (*Pascopyrum smithii*), needle and thread (*Hesperostipa comata*), blue grama (*Bouteloua gracilis*), galleta (*Pleuraphis jamesii*), New Mexico feathergrass (*Hesperostipa neomexicana*), and various species of three-awn (*Aristida* spp.). Common shrubs include big sagebrush (*Artemisia tridentata*), black sagebrush (*Artemisia nova*), fourwing saltbush (*Atriplex canescens*), and Mormon tea (*Ephedra trifurca*). One-seed juniper (*Juniperus monosperma*) and Utah juniper (*Juniperus osteosperma*) woodlands and savannas are adjacent to Colorado Plateau grasslands.

Historically, perennial and annual grasses covered much of this vegetation community in a clumpy, relatively continuous carpet interspersed with shrubs and forbs. The natural fire regime for this zone involves frequent fires, which occur an average of 10 years apart, nearly all of which have stand replacement fire severity. Frequent fires are limited to woody species with a varied vegetation pattern across the landscape. Changes in fuel continuity from past management practices and fire suppression activities essentially eliminated fire from this ecological zone, resulting in increased shrub densities, the loss of perennial grasses, and the spread of non-native, invasive species (BLM 2008b).

Great Basin Desertscrub

Great Basin Desertscrub occurs in the North and East parcels. Most of the mid- to lower-elevation basins and benchlands along major canyon systems are covered by this vegetation type, the majority of which is managed by the BLM and NPS (AGFD 2006a). This vegetation community is shrub dominated. Species diversity is low, with dominant shrubs occupying large tracts of land. Characteristic vegetation is low-growing, widely spaced hemispherical, non-sprouting shrubs with widely spaced bunchgrasses. Dominant shrubs include big sagebrush, black sagebrush, Bigelow sagebrush (*Artemisia bigelovii*), shadscale (*Atriplex confertifolia*), fourwing saltbush, rabbitbrush (*Chrysothamnus* spp.), winterfat (*Krascheninnikovia lanata*), hopsage (*Grayia spinosa*), horsebrush (*Tetradymia* spp.), blackbrush (*Coleogyne ramosissima*), and greasewood (*Sarcobatus vermiculatus*). Associated grasses may include blue grama, galleta, Indian ricegrass (*Achnatherum hymenoides*), western wheatgrass, junegrass (*Koeleria macrantha*), muttongrass (*Poa fendleriana*), and several muhleys (*Muhlenbergia* spp.) and dropseeds (*Sporobolus* spp.). Forbs include several gilia (*Gilia* spp.), buckwheat (*Eriogonum* spp.), penstemon (*Penstemon* spp.), lupine (*Lupinus* spp.), and globemallow (*Sphaeralcea* spp.) species. Cacti are poorly represented in Great Basin Desertscrub, compared with their occurrence in warm deserts. Cacti in the proposed withdrawal vicinity include several species of prickly pear (*Opuntia* spp.), hedgehog (*Echinocereus* spp.), and cholla (*Cylindropuntia* spp.).

Great Basin Conifer Woodland

Great Basin Conifer Woodland is present in all three proposed withdrawal parcels but is best represented within the North and South parcels. This vegetation community is classified as evergreen woodland dominated by juniper (*Juniperus* spp.) and pinyon pine (*Pinus* spp.) trees. Juniper tends to dominate at elevations below 6,560 feet amsl, while pinyon pine dominates at higher elevations. These trees are low growing, rarely exceeding 40 feet in height. The understories of pinyon-juniper and dense mature juniper woodlands are very species-poor, containing only widely scattered shrubs, forbs, and small clumps of grass. Grasses are the most common understory component.

The species of pinyon most often present in the Great Basin Conifer Woodland is the common pinyon (*Pinus edulis*), with singleleaf pinyon (*Pinus monophylla*) occasionally being found. Utah juniper is the most common juniper present, with one-seed juniper occasionally found. The understory contains only widely scattered shrubs, forbs, and small clumps of grass. Grasses are the most common understory component. Dominant grass species include grama, Arizona fescue (*Festuca arizonica*), junegrass, Indian ricegrass, needlegrass (*Achnatherum* spp.), dropseed, and squirreltail (*Elymus elymoides*). Shrubs may include big sagebrush, cliffrose (*Purshia stansburiana*), broom snakeweed (*Gutierrezia sarothrae*), Utah serviceberry (*Amelanchier utahensis*), rabbitbrush, shadscale, and winterfat.

This habitat type has expanded in distribution and density predominantly on public lands managed by the Kaibab National Forest, Grand Canyon National Park, ASLD, and BLM (AGFD 2006a). The community is replacing grassland vegetation in many locations as a result of livestock grazing, fire suppression, introduction of nonnative species, and other activities, many of which cause changes in vegetative composition through the creation of conditions that favor woody species over perennial grasses and forbs. Much of the vegetative diversity provided by grassland communities is lost when pinyon-juniper vegetation becomes established in nearly monotypic stands (AGFD 2006a).

Petran Montane Conifer Forest

Within the proposed withdrawal area, this vegetation community is found only on the South Parcel. It is dominated by ponderosa pine (*Pinus ponderosa*), with Gambel oak (*Quercus gambellii*) being the most common associate. Other species include New Mexican locust (*Robinia neomexicana*) and serviceberry, both usually growing as shrubs or small trees. At lower elevations, ponderosa pine may be found mixed with pinyon and juniper. The understory of more open stands supports abundant grasses and forbs. Shrubs present include those from adjoining communities, along with scattered individuals of mountain snowberry (*Symphoricarpos oreophilus*), Oregon grape (*Mahonia repens*), and Oregon boxleaf (*Paxistima myrsinites*).

Most of the Petran Montane Conifer Forest in the Colorado Plateau ecoregion is found on the Kaibab Plateau north and south of the Grand Canyon. This forested land is managed by the Forest Service and NPS. While disagreement exists in the academic and scientific communities regarding estimates of pre-settlement conditions, it remains obvious that the structure and makeup of the montane conifer forests are different, in many respects, from historic conditions (AGFD 2006a). The large, mature, “old-growth” forests of the ecoregion were replaced by dense stands of even-age ponderosa pine as a result of heavy commercial logging and associated fire-suppression activities. The more than 100 years of fire suppression has resulted in dense, closed-canopy ponderosa pine forests with abundant litter and limited herbaceous vegetation. Heavy fuel loads have caused stand replacement fires in large wildfire events over the past 25 to 30 years.

3.6.2 Invasive and Noxious Species

There are occurrences of invasive species in the proposed withdrawal area. Some of these have been designated as “noxious” weeds in the state of Arizona, meaning they have been determined to be detrimental to public health, agriculture, recreation, wildlife, or property (BLM 2009a). Although it appears that there are relatively fewer noxious weed infestations on the Kanab Plateau and House Rock Valley than in nearby areas, the North and East parcels are apparently susceptible to invasions from the north and the south (BLM 2008d). Nine noxious weed species are found on the Arizona Strip: Russian knapweed (*Acroptilon repens*), camelthorn (*Alhagi maurorum*), globed-podded hoary cress/whitetop (*Cardaria draba*), diffuse knapweed (*Centaureau diffusa*), spotted knapweed (*Centaureau maculosa*), halogeton (*Halogeton glomeratus*), three-lobed morning glory (*Ipomoea triloba*), puncturevine (*Tribulus terrestris*), and Scotch thistle (*Onopordum acanthium*). The locations of known noxious weeds on the Kanab Plateau and Kaibab National Forest are depicted on Map 3.12 in BLM (2007:Vol. 1, Ch. 3). There also are six additional invasive species on the Arizona Strip that have not been designated as noxious but that are non-native in this region: perennial pepperweed (*Lepidium latifolium*), saltcedar, Russian olive, cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), and Malta star thistle (*Centaurea melitensis*). Medusahead (*Taeniatherum caput-medusae*), a non-native species, is established north of the proposed withdrawal area and may occur within the proposed withdrawal area in the future (BLM 2008b).

Noxious and invasive weeds found on the Kaibab National Forest include cheatgrass, Dalmatian toadflax (*Linaria dalmatica*), diffuse knapweed, Scotch thistle, bull thistle (*Cirsium vulgare*), and leafy spurge (*Euphorbia esula*) (Forest Service 2009a). Cheatgrass occurs throughout the Kaibab National Forest and Grand Canyon National Park. Dalmatian toadflax has been found on and around the Kaibab National Forest, including along SR 64, and along roadsides in Grand Canyon National Park. Diffuse knapweed has been found on the Kaibab National Forest and along SR 64, crossing the eastern boundary of Grand Canyon National Park to the Navajo Nation boundary. Scotch thistle has been found along SR 64 at the eastern boundary with Grand Canyon National Park and on many forest roads on the Kaibab National Forest. A few scattered bull thistle plants have been found in the interior of the Kaibab National Forest and in scattered locations in Grand Canyon National Park. Leafy spurge has been found within the Hull Cabin Historic District on the Kaibab National Forest. Most of these populations have been treated using manual, chemical, or biological control methods. Invasive non-native weed monitoring, new treatments, and re-treatments occur annually on the Arizona Strip and in Grand Canyon National Park. Currently, the Kaibab National Forest, Grand Canyon National Park, and several field offices of the BLM are engaged with multiple other parties as part of a Memorandum of Understanding to manage noxious weeds as the Washington County Cooperative Weed Management Area (CWMA). This memorandum outlines a formal agreement to "promote an integrated weeds management program throughout the Washington County CWMA that includes public relations, education and training in the noxious weed arena, as well as coordination of weed control efforts and methods, sharing of resources and designing other desirable resource protection measures relative to weed management."

3.6.3 Resource Condition Indicators

For vegetation resources, condition indicators include the

- amount of disturbance that would result in loss of vegetation;
- change in productivity;
- loss of diversity;
- degree of infestation of invasive species;
- degree and amount of fragmentation;
- degree and amount of contamination and loss of water resources for vegetation.

For a more detailed description of changes in vegetation spatial pattern and area occupied, see the habitat fragmentation discussion in the Fish and Wildlife section (Section 3.7).

3.7 FISH AND WILDLIFE

The proposed withdrawal area is located within the greater Colorado Plateau ecoregion, which supports a wide variety of terrestrial and aquatic wildlife species. With the exception of Kanab Creek on the Kaibab Plateau, perennial aquatic systems and associated riparian habitats are extremely rare within the proposed withdrawal area; therefore, fish and riparian-dependent wildlife species are naturally limited. However, aquatic and riparian habitats are relatively abundant, adjacent to the proposed withdrawal area along the Colorado River, seeps and springs, and associated drainages in Grand Canyon National Park.

The USGS reviewed historical hydrologic data and analyzed water samples to determine uranium levels in Northern Arizona (Bills et al. 2010). Preliminary results suggest that dissolved uranium concentrations in areas without mining were generally similar to those with active or reclaimed mines, except for Horn Creek, which has high levels of uranium, arsenic, and other toxic metals. Horn Creek is located within the Park and has been previously impacted from the Orphan Mine. Historical water-quality and water-chemistry data evaluated for approximately 1,000 water samples determined that approximately 16% have exceeded maximum contaminant levels for arsenic, iron, lead, manganese, radium, sulfate, and uranium (Bills et al. 2010). These data suggest that water recharged from the surface or from perched water-bearing zones may contain dissolved gypsum from overlying rock units or may have been in contact with sulfide-rich ore. The USGS summarize that a few springs and wells in the region contain concentrations of dissolved uranium greater than the EPA MCL of 30 μg/L (Bills et al. 2010). These springs and seeps are in close proximity to or in direct contact with orebodies. Sixty-six percent of natural water sample concentrations of dissolved uranium in the dataset were 5 μg/L or less, and they may be subjectively be classified as low concentrations for human consumption within the study area (Bills et al. 2010).

The USGS also performed a literature review and analysis (Hinck et al. 2010) to document taxa-specific (i.e., birds, fish, amphibians, reptiles, small mammals, large mammals, etc.) plant and wildlife threshold levels for uranium or other metals. Based on the finding of this report, it is apparent that many plant and wildlife species are susceptible at levels below the EPA drinking water standards for humans. Impacts include reproductive issues, added pressure from more uranium tolerant species, and mortality.

General wildlife species associated with northern Arizona and the proposed withdrawal area are discussed in Table 3.7-1 and within various subsections of Section 3.7. Federally protected species, resource agency management indicator species (MIS), and agency-listed sensitive species are addressed in Section 3.8. The term 'possible' is defined as being when a species has a high probability of occurring because documented habitat components are present, the species may exist in close proximity to the proposed withdrawal area, or the species may be affected by actions proposed in one or more of the alternatives.

3.7.1 Wildlife Linkages

Establishing linkages between natural lands has long been recognized as important for sustaining natural ecological processes and biological diversity. For any linkage analysis, it is important to identify a suite of species on which recommendations will be focused, as the concept of focal species in reserve design and wildlife connectivity is a central theme in local and regional conservation planning (Miller et al. 1998; Soulé and Terborgh 1999). Focal species are typically identified to symbolize ecological conditions that are critical to healthy, functioning ecosystems (Lambeck 1997). The proposed withdrawal area overlaps with or is located immediately adjacent to five linkages identified by the Arizona Wildlife Linkages Workgroup (2006) (Figure 3.7-1). Focal species identified for these five linkages by the Arizona Wildlife Linkages Workgroup (2006) include large-game species, BLM and Forest Service Sensitive species, and NPS Species of Concern. No federally listed threatened or endangered species were included among the focal species identified for these linkages.

- **Linkage 3: Cedar Rim–Fredonia Pronghorn Crossing**. Linkage 3 consists of private, State Trust land, tribal, and BLM lands (although BLM lands make up only 9% of the linkage). Focal species associated with this linkage include mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), mountain lion (*Puma concolor*), and a variety of bats. Primary threats to this linkage include urbanization and SR 389.
- **Linkage 5: Kaibab Plateau North Rim.** Linkage 5 consists primarily of National Forest System land, with small amounts in private ownership or managed by NPS and BLM. Among the focal species associated with this linkage are mule deer, mountain lion, and wild turkey (*Meleagris gallopavo*). The major threat to this linkage is SR 67.
- **Linkage 6: Paria Plateau–Kaibab Plateau.** Linkage 6 consists primarily of BLM land, with small amounts of Forest Service, NPS, ASLD State Trust, tribal, and private land. Among the focal species associated with this linkage are pronghorn, mule deer, desert bighorn sheep (*Ovis canadensis nelsoni*), chisel-toothed kangaroo rat (*Dipodomys microps*), and western burrowing owl (*Athene cunicularia hypugea*). Threats to this linkage are listed as U.S. 89A, BLM Road 1065, and recreational traffic.
- **Linkage 12: Coconino Plateau–Kaibab National Forest.** Linkage 12 consists primarily of private and State Trust land, with small amounts of Forest Service and NPS land. Focal species include elk (*Cervus canadensis*), mule deer, mountain lion, northern goshawk (*Accipiter gentilis*

atricapillus), and pronghorn. Threats to this linkage include SR 64, the Grand Canyon railroad, and urbanization.

- **Linkage 13: South Rim Grand Canyon.** Linkage 13 consists primarily of tribal and Forest Service land, with a small amount of private land. Focal species include mule deer, elk, desert bighorn sheep, and mountain lion. Threats include SR 64, urbanization, and recreational traffic.

Table 3.7-1. General Wildlife Species Summary

Species	Documented in the Proposed Withdrawal Area?	Documented in Close Proximity to the Proposed Withdrawal Area?	ESA status	Forest Service Management Indicator Species?	General Wildlife (per BLM and Forest Service)?	AGFD Species of Greatest Conservation Need in Arizona?	Potentially Impacted by Proposed Withdrawal?
Mammals							
Desert bighorn sheep (*Ovis canadensis nelsoni*)	Yes	Yes	No	Yes	Yes	No	Yes
Mule deer (*Odocoileus hemionus*)	Yes	Yes	No	Yes	Yes	No	Yes
Pronghorn (*Antilocapra americana*)	Yes	Yes	No	Yes	Yes	No	Yes
Elk (*Cervus canadensis*)	Yes	Yes	No	Yes	Yes	No	Yes
Mountain lion (*Puma concolor*)	Yes	Yes	No	No	Yes	Yes	Yes
Bison (*Bison bison*)	Yes	Yes	No	No	Yes	No	Yes
Birds							
Merriam's turkey (*Meleagris gallopavo merriami*)	Yes	Yes	No	Yes	No	No	Yes
Plain (Juniper) titmouse (*Baeolophus ridgwayi*)	Yes	Yes	No	Yes	No	No	Yes
Pygmy nuthatch (*Sitta pygmaea*)	Yes	Yes	No	Yes	No	No	Yes
Lucy's warbler (*Vermivora luciae*)	Yes	Yes	No	Yes	No	No	Yes
Yellow-breasted chat (*Icteria virens*)	Possible	Yes	No	Yes	No	No	Yes
American three-toed woodpecker (*Picoides tridactylus*)	Possible	Possible	No	No	No	Yes	Yes
Western purple martin (*Progne subis*)	Possible	Possible	No	No	No	Yes	Yes
Red-naped sapsucker (*Sphyrapicus nuchalis*)	Possible	Possible	No	No	No	Yes	Yes
Lewis's woodpecker (*Melanerpes lewis*)	Possible	Possible	No	No	No	Yes	Yes
Lincoln's sparrow (*Melospiza lincolnii*)	Possible	Possible	No	No	No	Yes	Yes
MacGillivray's warbler (*Oporornis tolmiei*)	Possible	Possible	No	No	No	Yes	Yes
Downy woodpecker (*Picoides pubescens*)	Possible	Yes	No	No	No	Yes	Yes
Green-tailed towhee (*Pipilo chlorurus*)	Possible	Possible	No	No	No	Yes	Yes
Ruby-crowned kinglet (*Regulus satrapa*)	Possible	Yes	No	No	No	Yes	Yes
Golden-crowned kinglet (*R. Calendula*)	Possible	Yes	No	No	No	Yes	Yes
Aquatics							
Bluehead sucker (*Catostomus discobolus*)	Possible	Yes	No	No	No	Yes	Yes
Aquatic invertebrates	Yes	Yes	No	Yes	No	No	Yes

3.7.2 Fish and Aquatic Resources

The majority of standing surface waters in the Colorado Plateau ecoregion was created by impoundment of major river systems. The exception being the Colorado River and several small lakes associated with seeps and springs located both north and south of the Grand Canyon, including within the proposed withdrawal area. Human-made flood-control impoundments can significantly influence the flows, sediment transport, water quality, and aquatic habitat characteristics. Loss of natural flow, temperature, and nutrient cycling regimes can occur and have associated impacts on native aquatic species. This is compounded in most instances by the introduction of non-native fish, crustacean, and amphibian species for sport fishing. Unnatural conditions can also be created on the stream banks as well with the rapid expansion of invasive non-native plant species such as saltcedar. For a more detailed description of water resources associated with the proposed withdrawal area, see Section 3.4 and Figures 3.4-9, 3.4.10, 3.4-11, and 3.4.13.

Unique habitats that form a small part of the overall habitats represented in the proposed withdrawal area, or on adjacent lands, can be quite important to biota, as evidenced by the large number of endemic species in northern Arizona. Numerous springs and seeps associated with the Colorado River drainage support particularly rare or endemic species (NPS 2009a). With the exception of a short perennial stretch (less than 0.5 mile long) of Kanab Creek, where Clear Water Spring flows into Kanab Creek about 14 miles south of Fredonia on the Kanab Plateau, and within the North Parcel (BLM 2008b), there are no perennial stream reaches on the proposed withdrawal area. It should be noted that Kanab Creek, downstream of the North Parcel, is also perennial and has potential to be impacted by the Proposed Action. Springs and seeps also are rare features on the proposed withdrawal area (BLM 2008b; Forest Service 2009a). Consequently, there are no sizable wetlands within the proposed withdrawal area and few in the ecoregion (BLM 2008b). Water sources in the proposed withdrawal area consist of small, ephemeral water bodies that develop in low-lying areas where seasonal runoff collects and water developments such as earthen tanks for livestock exist.

3.7.3 General Wildlife Species

Species representative of aquatic/riparian, grassland, desertscrub, pinyon-juniper woodland, and ponderosa pine forest are listed in Table 3.7-2. Descriptions and species listed are from Brown and Lowe (1980). A variety of game species (including mule deer, elk, pronghorn, and turkey) and non-game wildlife species are discussed below under MIS. Two additional game species—desert bighorn sheep, a Forest Service Sensitive species, and bison (*Bison bison*), no special status—are not included in the MIS section. Desert bighorn sheep is discussed in Section 3.8.3, below. Bison is included in the discussion of the Grand Canyon Game Preserve, below.

Table 3.7-2. Representative Wildlife by Vegetation Community

Vegetation Community	Representative Wildlife Species
Aquatic/Riparian	Birds characteristic of well-developed riparian communities include Bell's vireo (*Vireo belli*). Spring habitats are important for distinct populations of invertebrates (e.g., springsnails [*Pyrgulopsis* spp.] and ambersnails [*Oxyloma* spp.]). Aquatic habitats are important for amphibians and fish (e.g., speckled dace [*Rhinichthys osculus*]).
Great Basin Grassland	The most well-known Great Basin Grassland mammal representative is the pronghorn (*Antilocapra americana*). Associated smaller mammals found in this community include pocket gopher (*Geomys* spp.), harvest mouse (*Reithrodontomys* spp.), and chisel-toothed kangaroo rat (*Dipodomys microps*). Grassland birds may include Brewer's sparrow (*Spizella breweri*), western meadowlark (*Sturnella neglecta*), prairie falcon (*Falco mexicanus*), and western burrowing owl (*Athene cunicularia hypugaea*).

Table 3.7-2. Representative Wildlife by Vegetation Community (Continued)

Vegetation Community	Representative Wildlife Species
Great Basin Desertscrub	A distinctive fauna is centered in the Great Basin Desertscrub vegetation community in northern Arizona. Mammals such as Townsend's ground squirrel (*Spermophilus townsendi*), long-tailed pocket mouse (*Perognathus* f*ormosus*), and northern grasshopper mouse (*Onychomys leucogaster*) are closely associated with sagebrush in the Great Basin Desertscrub. Large ungulates are poorly represented here, but mule deer and bighorn sheep are known to use this vegetation community. Birds characteristic of this community include sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), and Vesper sparrow (*Pooecetes gramineus*). Characteristic reptile and amphibian species include sagebrush lizard (*Sceloporus graciosus*) and Great Basin spadefoot toad (S*pea intermontanus*), respectively. A number of reptile subspecies such as desert horned lizard (*Phrynosomo platyrhihnos platyrhinos*) and Great Basin and Plateau tiger whiptails (*Aspidoscelis tigris tigris* and *A. tigris septentrionalis,* respectively) are indicative of Great Basin Desertscrub.
Great Basin Conifer Woodland	Vertebrate species closely tied to or centered within this vegetation community in northern Arizona include pinyon mouse (*Peromyscus truei*), pinyon jay (*Gymnorhinus cyanocephalus*), gray flycatcher (*Empidonax wrightii*), bushy-tailed woodrat (*Neotoma cinerea*), gray vireo (*Vireo vicinior*), juniper titmouse (*Baeolophus ridgwayi*), black-throated gray warbler (*Dendroica nigrescens*), Scott's oriole (*Icterus parisorum*), and Plateau striped whiptail (*A. velox*) (Brown 1994). Pinyon-juniper woodlands are also seasonal habitats for a number of montane animals; as such, they are often of great importance as winter range for elk and mule deer.
Petran Montane Conifer Forest	Several species of wildlife are dependent on ponderosa pine, including Kaibab and Abert's squirrel (*Sciurus aberti kaibabensis* and *S. aberti,* respectively), northern goshawk, and Merriam's turkey. The list of characteristic nesting avifauna includes flammulated owl (*Otus flammeolus*), white-breasted nuthatch (*Sitta carolinensis*), pygmy nuthatch (*S. pygmaea*), brown creeper (*Certhis familiaris*), western bluebird (*Sialia mexicana*), yellow-rumped warbler (*Dendroica coronata*), western tanager (*Piranga ludoviciana*), pine siskin (*Carduelis pinus*), and chipping sparrow (*Spizella passerine*). Ponderosa pine forests support a wide variety of neotropical migratory songbirds.

Grand Canyon Game Preserve

The Grand Canyon Game Preserve is located between the Kanab Plateau and House Rock Valley on the Kaibab Plateau, a portion of which is within the northern reaches of the South Parcel. The Grand Canyon Game Preserve was established through presidential proclamation in 1906 by Theodore Roosevelt and specifically designated within the Grand Canyon Forest Reserve (now the Kaibab National Forest). The reason for establishment of the preserve was related to concerns about the extirpation of game species through unregulated hunting. In order to maximize populations of game species, government-sanctioned hunters virtually eliminated predators in the preserve, leading to overpopulation by the Kaibab deer herd in the 1920s. Management of the game preserve now falls under the Kaibab Land Management Plan (Forest Service 1996), which incorporates management directed toward ecosystem enhancement preserve for a broad range of habitat types and variety of wildlife species. Numerous cooperating agencies work to achieve the management goals and objectives specified in the Arizona wildlife and fisheries comprehensive plan (AGFD 2007a) and cooperative agreement for the management of the Grand Canyon Game Preserve.

Prior to the establishment of the game preserve, a herd of bison was introduced into House Rock Valley in 1906 (BLM 2008b). A portion of the herd still uses this area during the winter months and is managed as part of the Houserock Valley Wildlife Area. During the warm season, however, most of the bison move upslope to graze in the game preserve and Grand Canyon National Park. On the game preserve, the bison are managed under a Memorandum of Understanding between the Forest Service and AGFD, initially signed on August 8, 1950.

Management Indicator Species

The role of MIS in National Forest System planning is described in the 1982 implementing regulations for the National Forest Management Act of 1976. Forest Service Manual 2620.5 defines management indicators as "plant and animal species, communities or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management

activities on their populations and the populations of other species with similar habitat needs which they may represent" (Forest Service 1991). These regulations require that certain vertebrate and/or invertebrate species present in the area be identified as MIS and that these species be monitored, as "their population changes are believed to indicate the effects of management activities" [36 CFR 219.19(a)(1)].
Table 3.7-3 is a list of MIS species for National Forest System lands associated with the proposed withdrawal area. The list is based on MIS of the Kaibab National Forest, as described in Foster et al. (2010), and input from Kaibab National Forest biologists. Included in the table are the habitat types or habitat components for which these MIS species are indicators. MIS species information is from Foster et al. (2010) and Forest Service (2008d), unless indicated otherwise.

Table 3.7-3. Wildlife Management Indicator Species on the Proposed Withdrawal Areas

Common Name	Scientific Name	Habitat or Habitat Component	Proposed Withdrawal Parcel
Invertebrates			
Aquatic macroinvertebrates	Includes mayflies, stoneflies, and caddisflies	Riparian	North
Birds			
Northern goshawk	*Accipiter gentilis atricapillus*	Late-seral ponderosa pine	South
Merriam's turkey	*Meleagris gallopavo merriami*	Late-seral ponderosa pine	South, East
Hairy woodpecker	*Picoides villosus*	Snags in ponderosa pine, mixed-conifer, and mixed-conifer with aspen habitats	South
Juniper titmouse	*Baeolophus ridgwayi*	Late-seral pinyon-juniper and snags in pinyon-juniper	All three parcels
Pygmy nuthatch	*Sitta pygmaea*	Late-seral ponderosa pine	South, East
Lucy's warbler	*Vermivora luciae*	Late-seral low-elevation riparian	North
Yellow-breasted chat	*Icteria virens*	Late-seral low-elevation riparian	North
Mammals			
Elk	*Cervus canadensis*	Early-seral ponderosa pine, mixed conifer, spruce-fir	South
Mule deer	*Odocoileus hemionus*	Early-seral aspen and pinyon-juniper	All three parcels
Pronghorn	*Antilocapra americana*	Early- and late-seral grassland	South, East
Abert's squirrel	*Sciurus aberti*	Early-seral ponderosa pine	South

Although northern goshawk is addressed in the Special Status Species section of this chapter, management recommendations developed for goshawk by Reynolds et al. (1992) are a major driver of forest management in the southwestern United States, including the Kaibab National Forest in the proposed withdrawal area, and are therefore described briefly here. The Kaibab LRMP/ROD (Forest Service 1988) prescribes the goshawk guidelines to all forest and woodland habitats on the Kaibab National Forest, with the exception of Mexican spotted owl (*Strix occidentalis lucida*) protected, restricted, and designated critical habitat, all of which have their own guidelines, which take precedence.

Goshawk management recommendations describe desired forest conditions for nesting, post-fledging, and foraging habitat while emphasizing conditions that support diverse prey populations (Foster et al. 2008). Fire, forest thinning, and snag retention are important components of the plan. The Kaibab LMP/ROD prescribes leaving snags in forested habitats to support goshawk prey species (Forest Service 1996).

PINYON-JUNIPER WOODLAND

The two MIS associated with pinyon-juniper woodland in the proposed withdrawal vicinity are juniper titmouse (*Baeolophus ridgwayi*) and mule deer.

Juniper titmouse (*Baeolophus ridgwayi*)

Juniper titmouse is an obligate secondary cavity nester. They typically nest in natural cavities such as knotholes or broken branches but will also use woodpecker-excavated cavities or stump holes as well as nest boxes. They are most abundant where juniper is dominant and where large, mature trees provide natural cavities for nesting. They are non-migratory and reside mainly in pinyon-juniper woodlands throughout the year. Juniper titmice occasionally wander into other habitats that are adjacent to or near pinyon-juniper woodlands, including cottonwood, willow, buffaloberry (*Shepherdia argentea*), and sagebrush shrublands, during the nonbreeding season.

Changes in historic fire regimes and habitat conversion resulting from livestock grazing are two major potential management impacts on the juniper titmouse.

Mule deer (*Odocoileus hemionus*)

Mule deer are generalists that use ponderosa pine, mixed-conifer, woodland, and chaparral habitats. Forage items mostly consist of a variety of woody browse, but they feed more on grasses and forbs during the spring and summer months. Important forage plants include mountain-mahogany (*Cercocarpus ledifolius*), buckbrush (*Ceanothus cuneatus*), cliffrose, sagebrush, buckthorn (*Rhamnus* spp.), juniper, and oak.

Mule deer apparently were not common on BLM Arizona Strip lands prior to the arrival of early settlers (BLM 2008b). Populations began increasing during the early 1900s and peaked during the 1960s following decades of intensive predator control measures. The AGFD considers the current mule deer population on the Arizona Strip to be low but stable (BLM 2008b). Numerous water sources have been developed to make more habitats accessible to deer.

PONDEROSA PINE FOREST

The five MIS associated with ponderosa pine forest in the proposed withdrawal area are Merriam's turkey (*Meleagris gallopavo merriami*), hairy woodpecker (*Picoides villosus*), pygmy nuthatch (*Sitta pygmaea*), elk, and Abert's squirrel (*Sciurus aberti*).

Merriam's turkey (*Meleagris gallopavo merriami*)

National forests contain the majority of turkey habitat in Arizona. Merriam's turkeys are found primarily in ponderosa pine forests with a mix of meadows, oak, and juniper. Roosting and nesting habitat consists of large, open-crowned trees, often on steep slopes. Good brood-rearing habitats include natural or created openings, riparian areas, abundant herbaceous vegetation adjacent to forest cover, and mid-day loafing and roosting areas. Turkeys are migratory in parts of their range, moving to lower elevations during winter. Timing of movements can differ annually, depending on snowfall. Current conditions on National Forest System lands provide suitable habitat for turkeys. Small-scale thinning and prescribed burning create open areas for foraging while preserving denser areas for nesting.

Hairy woodpecker (*Picoides villosus*)

Hairy woodpecker is one of the most abundant primary cavity nesters in northern Arizona. It is widely distributed wherever there are mature forests with substantial snags. Hairy woodpeckers occur in both deciduous and coniferous forests but may show preference for open pine forests in the Southwest. Although it is more abundant in Arizona pine forests, hairy woodpeckers are also found in pinyon-juniper woodland in the north and some Upper Sonoran deciduous woodlands and riparian areas in the south. Hairy woodpeckers are strongly associated with burned areas, an important historical component of northern Arizona forests resulting from frequent intervals of fire.

As primary cavity nesters, hairy woodpeckers are dependent on dead or dying portions of live trees and snags. They excavate their nests in both live and dead conifers and deciduous trees such as quaking aspen (*Populus tremuloides*) with fungal heart rot. The primary conifer species used for nesting in northern Arizona is ponderosa pine. Hairy woodpeckers prefer to drill their cavities on the underside of a curved limb in a somewhat open location.

Hairy woodpeckers primarily eat insects from the surface and subsurface of trees but also consume a diversity of fruits and seeds. In the western United States, they prefer to forage on conifers. In northern Arizona, they forage on ponderosa pine and are found in greater densities in burned areas. In turn, they are an important prey resource to many raptors, including the northern goshawk, Cooper's hawk (*Accipiter cooperi*), sharp-shinned hawk (*Accipiter striatus*), and great-horned owl (*Bubo virginianus*).

Hairy woodpecker populations are believed to be stable on the Kaibab National Forest. Based on the existing snag policy, guidelines for habitat manipulations, and the increasing severity of forest fires and number of acres burned in the Southwest, it is likely that hairy woodpecker populations will increase in the future.

Pygmy nuthatch (*Sitta pygmaea*)

Pygmy nuthatch is one of the most abundant species in ponderosa pine forests. It is virtually limited to long-leaf pine systems, including ponderosa pine and Jeffrey pine (*Pinus jeffreyi*). In northern Arizona, pygmy nuthatches breed and feed in ponderosa pine communities and also in shallow ravines that contain white fir (*Abies concolor*), Douglas-fir, Arizona white pine (*P. monticola*), quaking aspen, and an understory of maple (*Acer* spp.). Pygmy nuthatches prefer old-growth, mature forests. However, this species can also be found in densely forested areas with smaller-diameter trees as long as there is nesting and roosting sites available, such as snags or trees with dead portions suitable for excavation. Ponderosa pine foliage volume positively correlates with pygmy nuthatch abundance, but abundance inversely correlates with trunk volume, which suggests that the species prefers heterogeneous stands of well-spaced, old pines and vigorous trees of intermediate age.

Pygmy nuthatches are both primary and secondary cavity-nesters, excavating dead or well-rotted wood, but also using existing cavities in northern Arizona. They nest primarily in ponderosa pine but occasionally use other conifers and quaking aspen if cavities are present. Pygmy nuthatches are primarily insectivorous. They forage in needle clusters and on cones, twigs, branches, and trunks. Pygmy nuthatches are assumed to be stable to declining on the Kaibab National Forest.

Elk (*Cervus canadensis*)

Elk are currently considered common on the Kaibab National Forest (South Parcel) but apparently only occur intermittently on the Kanab Plateau (North Parcel) and House Rock Valley (East Parcel). In addition to occupying ponderosa pine forests, elk graze grassland and woodland habitats within the Kaibab National Forest. Although they prefer grasses over forbs, they are associated with deciduous thickets and early-seral stages that contain an interspersion of grasses and forbs. Elk occupy mountain meadows and forests in summer and move to lower-elevation pinyon-juniper woodland, conifer forest, and grasslands in winter, where they will browse woody shrubs. The population trend for elk has been stable to increasing on the Kaibab National Forest.

Mountain lion (*Puma concolor*)

Mountain lions in Arizona use desert mountains with broken terrain and steep slopes, along with dense vegetation, caves, and rocky crevices that provide shelter. Stream courses and ridgetops are frequently used as travel corridors and hunting routes. Riparian vegetation along streams provides cover for lions traveling in open areas (AGFD 2007b). Mountain lions are active throughout the year, any time, day or night, but most hunting occurs at dawn or dusk. They are essentially solitary animals, with the exception for a few days during mating and periods of juvenile dependence. In Arizona, both whitetail (*Odocoileus virginianus*) and mule deer are the principal prey species, while in other areas, javelina (*Pecari tajacu*), elk, pronghorn, bighorn sheep, and/or livestock can be major components of their diets (AGFD 2007b). Population densities vary, depending on habitat components and density of prey items. Home range size for adult males is approximately 20 to 150 square miles, while for females it is approximately 10 to 50 square miles, both of which probably vary seasonally (AGFD 2007b). Territories of males and females may overlap, but males tend to avoid other males. Loss of habitat is probably the greatest threat to mountain lion populations throughout its range. Large tracts of roadless habitat are necessary to maintain individual populations, and the corridors that connect these tracts are required for dispersal of lions between populations. In addition, any loss of habitat of their prey species (deer) may cause a reduction in the mountain lion population.

Abert's squirrel (*Sciurus aberti*)

Abert's squirrel is a tassel-eared squirrel occurring south of the Grand Canyon. The species lives, nests, and forages in ponderosa pine forests. Preferred habitat structure is intermediate-aged ponderosa pine forest intermixed with larger trees, where groups of trees have crowns that are interlocking or in close proximity. Thickets of medium-sized trees, with fewer large trees per acre, also can provide favorable habitat for Abert's squirrel. Nests are typically built in the branches of large ponderosa pines. Other nest sites include cavities in Gambel oak and in dwarf mistletoe (*Arceuthobium* spp.). Abert's squirrels depend on the interspersion of habitat types within the forest to provide arboreal travel routes and food both on the ground and in the trees. Closed canopies and abundant snags represent forest conditions favorable for Abert's squirrels. Abert's squirrel populations are currently considered stable on the Kaibab National Forest.

GRASSLAND

The one MIS associated with grassland habitat in the proposed withdrawal area is pronghorn.

Pronghorn (*Antilocapra americana*)

Pronghorn are associated with grasslands and savannahs with scattered shrubs and rolling hills. It prefers forbs and grasses as forage but will browse on woody shrubs when forbs and grasses are not available. Rangeland with a low vegetative structure, averaging 15 to 24 inches in height, is considered prime pronghorn habitat. Pronghorn movements vary seasonally. Animals using habitat on the Tusayan Ranger District (South Parcel), for example, spend time on different game management units (GMUs), including areas south of the Kaibab National Forest.

Pronghorn are native to the proposed withdrawal area. However, they apparently were eliminated from the Arizona Strip in the early 1900s and reintroduced beginning in the 1960s (BLM 2008b). Much of the pronghorn habitat on the Arizona Strip is found in the Clayhole area (North Parcel) and House Rock Valley area (East Parcel). On the Kaibab National Forest, pronghorn occur primarily in the Upper Basin in the northeastern portion of the Tusayan Ranger District, the southeastern portion of the Tusayan Ranger District, and small grasslands and sagebrush-grass communities (Forest Service 2009b).

The development of private lands, fence lines, railroads, roads, and highways has resulted in the fragmentation of pronghorn habitat. On the Arizona Strip, pronghorn populations since the 1980s have been low but stable (BLM 2008b). Management actions to help restore pronghorn to their former ranges within the Arizona Strip include modifying fences to allow pronghorn movement, improving forage species composition and diversity, and developing or making other water sources available for pronghorns (BLM 2008b).

RIPARIAN

The three MIS associated with riparian habitat in the proposed withdrawal area are Lucy's warbler (*Vermivora luciae*), yellow-breasted chat (*Icteria virens*), and aquatic macroinvertebrates.

Lucy's warbler (*Vermivora luciae*)

The species is only one of two warblers in the United States that nest regularly in cavities. In Arizona, it is a common resident of low-elevation mesquite (*Prosopis* spp.) bosques, cottonwood-willow forests, and densely vegetated xeric-riparian washes. They are also found in mid-elevation ash-walnut-sycamore-live oak associations. Although considered a generalist, the preferred habitat for Lucy's warbler is dense mesquite. It has also recently begun breeding in saltcedar communities in the Grand Canyon region.

Within the proposed withdrawal area, only Kanab Creek is considered suitable habitat for Lucy's warbler. Because Lucy's warbler can nest in saltcedar, it is likely this species will persist on the Kaibab National Forest in Kanab Creek. Bird surveys conducted in Kanab Creek in 2001 failed to detect any Lucy's warblers. Lucy's warblers are likely stable within the limited habitat available on the Kaibab National Forest.

Yellow-breasted chat (*Icteria virens*)

The species prefers early-seral, shrubby thickets that are composed of low, dense vegetation with sparse canopy cover. This habitat type is found along forest edges, the margins of riparian or wetland habitat, regenerating burned areas, partially clearcut forests, and fencerows and thickets on abandoned farmland. In the arid western United States, chats are mainly confined to riparian and shrubby habitats. In Arizona, chats occur primarily in cottonwood-willow associations with a dense understory of mesquite and saltcedar along major rivers and ponds.

In the arid West, yellow-breasted chats build cup nests in dense, brushy, low-lying trees and shrubs, including Arizona alder (*Alnus oblongifolia*), Arizona ash (*Fraxinus velutina*), Russian olive, Siberian elm (*Ulmus pumila*), box-elder (*Acer negundo*), Goodding's willow (*Salix gooddingii*), coyote willow, blue-stem willow (*S. irrorata*), seep willow, canyon grape (*Vitis arizonica*), Virginia creeper (*Parthenocissus quinqurfolia*), net-leaf hackberry (*Celtis reticulata*), sumac (*Rhus trilobata*), and New Mexico forestiera (*Forestiera neomexicana*). In early successional shrubby habitats, where chats were more abundant, the preferred nesting substrates were seep willow, coyote willow (*S. exigua*), and canyon grape.

Very little riparian habitat suitable for this species is available within or adjacent to the proposed withdrawal area. What does occur consists primarily of dense, nonnative saltcedar and other native shrubs along Kanab Creek. The sometimes extensive saltcedar stands do not provide good foraging habitat and are increasing in distribution.

AQUATIC MACROINVERTEBRATES

Aquatic macroinvertebrates live in a variety of riparian habitats where water is present. As a group, they provide a vital link in the food chain between primary producers (algae and macrophytes) and fish and amphibians. Many species are useful indicators of aquatic habitat conditions. Within the proposed withdrawal area, MIS aquatic macroinvertebrates include mayflies (Order Ephemeroptera), stoneflies (Order Plecoptera), caddisflies (Order Trichoptera), and true flies (Order Diptera). Aquatic macroinvertebrates were selected for monitoring the health of late-seral, riparian habitats because a diverse and abundant array of these species is indicative of healthy riparian habitats on the Kaibab National Forest. Aquatic macroinvertebrates are sensitive to changes resulting from forest practices, such as timber harvest, grazing, and road building (NPS 2009a).

Aquatic macroinvertebrates are not considered an effective MIS on the proposed withdrawal area because of the absence of well-developed riparian areas. They are not effective management indicators when stream courses have cycles of spring runoff that subside into slow or stagnant reaches of warm, isolated, receding waters, as in Kanab Creek, although some reaches within the North Parcel are not stagnant.

3.7.4 Migratory Birds

The Migratory Bird Treaty Act of 1918 gives federal protection to all migratory birds, including nests and eggs. Under the MBTA [16 USC 703–711], it is unlawful to take, kill, or possess migratory birds except as permitted by regulations [50 CFR Subpart B]. EO 13186 of January 10, 2001 (*Federal Register* 66[11]:3853–3856), directs federal agencies to support migratory bird conservation and to “ensure that environmental analyses . . . evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern” [50 CFR Section 3d(6)]. Species of concern are defined as “those species listed in the periodic report ‘Migratory Nongame Birds of Management Concern in the United States,’ priority migratory bird species as documented by established plans (such as Bird Conservation Regions in the North American Bird Conservation Initiative or Partners in Flight physiographic areas), and those species listed in 50 C.F.R. 17.1” [50 CFR Section 2i].

The Bald and Golden Eagle Protection Act [16 USC 668–668c], enacted in 1940, and amended several times since then, prohibits anyone, without a permit issued by the Secretary of the Interior, from “taking” bald eagles (*Haliaeetus leucocephalus*), including their parts, nests, or eggs. This law provides for the protection of the bald eagle and the golden eagle (*Aquila chrysaetos*) by prohibiting, except under certain specified conditions, the taking, possession and commerce of such birds. Amendments were made in 1972 and 1978 and a 1994 Memorandum (*Federal Register* 59:22953, April 29, 1994) from President William J. Clinton to the heads of Executive Agencies and Departments sets out the policy concerning collection and distribution of eagle feathers for Native American religious purposes.

The USFWS has the legal mandate and the trust responsibility to maintain healthy migratory bird populations for the benefit of the American public. Management recommendations for migratory birds can be found in the *USFWS Migratory Bird Program Strategic Plan 2004–2014* (USFWS 2010a). A list of species protected as migratory birds can be found in USFWS (2010b) and Appendix 2.G of the Arizona Strip ROD/RMP (2008b). Latta et al. (1999) describe priority bird species of concern by vegetation type in Arizona. These vegetation types are in turn grouped into the pertinent physiographic areas at the Partners in Flight (2010) website. The following vegetation (habitat) types are found in the proposed withdrawal area: Great Basin Woodland, Great Basin Desertscrub, Petran Montane Conifer Forest, Great Basin Grassland, Riparian Wetland, and Cliff/Rock.

Numerous migratory bird species occur within the boundaries of the proposed withdrawal area. Many of the species classified as MIS also are classified as migratory (e.g., northern goshawk, Lucy’s warbler, yellow-breasted chat), as are many of the species analyzed in the Section 3.8 (e.g., northern goshawk, bald eagle, and peregrine falcon [*Falco peregrinus*]). In addition, bald eagle and golden eagle, which are both migratory species, have been observed within the proposed withdrawal area. Both are afforded added protection under the Bald and Golden Eagle Protection Act [16 USC 668–668c]. Vegetation (habitat) types and associated priority bird species of concern that may potentially occur in or adjacent to the proposed withdrawal area are listed in Table 3.7-4 and described based on information in Latta et al. (1999).

Table 3.7-4. Arizona Priority Bird Species by Vegetation Type

Vegetation Type	Species	Important Habitat Components
Great Basin Woodland		
Pinyon pine and/or juniper (may include several species)	Gray flycatcher (*Empidonax wrightii*)	Breeds in semi-arid woodlands and brushy areas that include pinyon pine and/or juniper woodlands, tall sagebrush/greasewood plains, and open ponderosa or Jeffrey pine forests with pinyon and/or juniper understory.
	Pinyon jay (*Gymnorhinus cyanocephalus*)	Pinyon pine seeds provide the primary source of reproductive energy for nesting. Food availability seems to be the most important factor determining colony breeding site selection. Open cup nests (usually one nest/tree) are placed in ponderosa pine, pinyon pine, Gambel oak, juniper, and occasionally blue spruce (*Picea pungens*).
	Gray vireo (*Vireo vicinior*)	Breeds in Arizona in open mature pinyon-juniper woodlands on canyon and mesa slopes from 3,200–6,800 feet amsl. A broadleaf shrub component is typically present, often composed of Utah serviceberry and single-leaf ash (*Fraxinus anomala*).
	Black-throated gray warbler (*Dendroica nigrescens*)	Primarily associated with pinyon pine and juniper woodlands (occasionally with scattered ponderosa pine) and mixed oak-pine woodlands. Breeding habitat is frequently characterized by a brushy undergrowth of scrub oak (*Quercus turbinella*), ceanothus (*Ceanothus* spp.), manzanita (*Arctostaphylos* spp.), or mountain mohagany (*Cercocarpus montanus*).
	Juniper titmouse (*Baeolophus ridgwayi*)	Highly restricted to pinyon-juniper woodlands. It occasionally wanders into other habitats (usually riparian) within its range that are adjacent to or near pinyon-juniper woodlands during the nonbreeding season.
Great Basin Desertscrub		
Sagebrush, blackbrush, shadscale, and greasewood	Sage thrasher (*Oreoscoptes montanus*)	In Arizona, primarily occupies big sagebrush but occurs in areas of sandsage (*Artemisia filifolia*), saltbush, and greasewood.
	Sage sparrow (*Amphispiza belli*)	Closely associated with pure stands of big sagebrush throughout their range or stands intermingled with bitterbrush (*Purshia* sp.), saltbush, shadscale, rabbitbrush, or greasewood.
	Brewer's sparrow (*Spizella breweri*)	Breeds exclusively in cold desertscrub, primarily sagebrush, but also in saltbush, shadscale, and greasewood.
Petran Montane Conifer Forest		
Ponderosa pine matrix (may include some Douglas-fir, Gambel oak, pinyon pine and/or juniper, aspen, and white fir)	Northern goshawk (*Accipiter gentilis atricapillus*)	Generally, nest sites are in mature and old-growth forest stands with relatively high canopy closure. In Arizona, primarily use ponderosa pine and mixed-conifer forests. In ponderosa pine habitat in Arizona, selected nest sites with higher canopy density, larger-diameter stems, and a higher frequency of large stems.
	Purple martin (*Progne subis*)	In Arizona ponderosa pine forests, prefers areas with a high snag density adjacent to or in open areas.
Great Basin Grassland		
Includes Great Basin grassland (with scattered pinyon-juniper)	Ferruginous hawk (*Buteo regalis*)	In Arizona, uses the open scrublands, woodlands, and grasslands in the northern and southeastern parts of the state. Most occupied areas include nearby slopes or knolls of widely scattered junipers.
	Burrowing owl (*Athene cunicularia hypugea*)	Found in open, dry grasslands, agricultural and range lands, and desert. Also inhabits grass, forb, and open shrub stages of pinyon pine and ponderosa pine habitats. In Arizona, predominantly associated with prairie dog (*Cynomys* spp.) towns and round-tailed ground squirrel (*Spermophilus tereticaudus*) populations.
Riparian Wetland		
Cottonwood, willow, ash, seepwillow, some saltcedar, and arrowweed	Western yellow-billed cuckoo (Cocc*yzus americanus occidentalis*)	A riparian obligate species found to be most abundant in cottonwood/willow associations. Breeds in riparian habitats, primarily below the Mogollon Rim in the Colorado and Gila river drainages.

Table 3.7-4. Arizona Priority Bird Species by Vegetation Type (Continued)

Vegetation Type	Species	Important Habitat Components
Riparian Wetland, continued		
	Southwestern willow flycatcher (*Strix occidentalis lucida*)	A riparian obligate species that requires dense habitats along rivers, streams, or other wetland areas, usually with surface water, where 10- to 30-foot-tall willows, seepwillow, arrowweed, buttonbush (*Cephalanthus occidentalis*), alder, or other shrubs and trees are present, often with a scattered overstory of cottonwood. Nests in thickets dominated by saltcedar and Russian olive.
	Lucy's warbler (*Vermivora luciae*)	Although classified as a generalist, the preferred habitat is dense mesquite. Will also use saltcedar, screwbean mesquite (*Prosopis pubescens*), and cottonwood willow (non-gallery).
Cliff/Rock		
Cliff, canyon wall, rock outcrop, talus slope	White-throated swift (*Aeronautes saxatalis*)	Occupies a wide variety of habitats, with the common attribute being the availability of nearby cliffs.
	Peregrine falcon (*Falco peregrinus*)	Occupies cliffs, canyon walls, and rock spires, usually near rivers or other water sources where prey is more abundant.
	Canyon wren (*Catherpes mexicanus*)	Found where topography provides appropriate substrates for foraging and nesting; steep slopes and canyons.

Source: Latta et al. (1999).

3.7.5 Resource Condition Indicators

For fish and wildlife resources, resource condition indicators include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and chemistry at aquatic sites), and the influence of these habitat changes on the reproductive success, population size, health, and diversity of organisms (Table 3.7-5). Many of these changes in habitat are similar to the condition indicators for vegetation. The concept of MIS was developed by the Forest Service to monitor selected ecological conditions (e.g., habitat quality) on National Forest System lands. The MIS concept is described in greater detail in Section 3.7.3, above.

Recognized threats to wildlife in the region include habitat loss and alteration, disturbance, introduction of non-native species, and increases to exposure of radiation and toxicity. The loss of habitat contiguity (i.e., fragmentation) is considered a particularly important reason for regional declines in native species and has been targeted as the most serious threat to biological diversity worldwide (Saunders et al. 1991; Wilcox and Murphy 1985). Countering this threat requires a systematic approach to identifying, protecting, and restoring functional connections across the landscape to allow essential ecological processes to continue operating. Habitat fragmentation typically leads to the isolation of populations, thus creating local subpopulations scattered across a landscape (Dobson et al. 1999). Isolation of these subpopulations may lead to local extinctions because, over time, populations restricted to isolated patches may experience a reduction in genetic diversity as a result of increased inbreeding, increased risk of local extinction from population dynamics and catastrophic events, and decreased ability to recolonize (Hanski 1999; Hanski and Simberloff 1997; Yanes et al. 1995).

Table 3.7-5. Fish and Wildlife Resource Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Wildlife habitat	Issues associated with wildlife habitat include fragmentation of habitat by roads, noise from exploration or development activities that is disruptive to wildlife, wildlife being disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator:* Acres and type of habitat lost and duration of loss. *Indicator:* Changes in migratory or foraging behavior. *Indicator:* Changes in road densities in migration corridors. *Indicator:* Avoidance or adaptation of species to noise source/visual intrusion. *Indicator:* Acres of habitat loss or degradation as a result of establishment of invasive species caused by mineral exploration or development activities.
Wildlife populations	Potential loss of critical wildlife winter range. Potential for exploration or development to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator:* Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Wildlife mortality and reproductive success	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle-wildlife accidents and associated wildlife mortality. In addition to vehicle wildlife accidents; increased uranium levels in surface and groundwater and soil contamination has potential to cause increased mortality and decreased reproductive success due to exposure of chemicals and radiation.	*Indicator:* Estimated number of vehicle-wildlife collisions associated with exploration or production activity. *Indicator:* Changes in uranium and other heavy metal levels in soils as well as on the surface and in surface waters such as rivers, streams and seeps, springs, and stock tanks fed by wells.

3.8 SPECIAL STATUS SPECIES

Special status species addressed below include 1) species listed or being considered for listing by the USFWS under the ESA; 2) BLM Sensitive species; 3) Forest Service Sensitive species; 4) NPS species of concern; and 5) AGFD Species of Greatest Conservation Need (SGCN). Figures depicting plant and animal locations are based on BLM (2008b) and data files provided by the BLM, Forest Service, and NPS. Table 3.8-1 summarizes species status and potential occurrence within the proposed withdrawal area and adjacent lands. It should be noted that some species are listed as special status species by multiple agencies. For those species that are listed as special status species by multiple agencies, the species description is included only once within Section 3.8.

Wildlife can be exposed to chemical and radiation hazards through various pathways, including ingestion (soil, food, and water), inhalation, and various cell absorption processes. In addition to the resource condition indicators discussed in Section 3.7, Fish and Wildlife, resource condition indicators for special status species include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and quantity at aquatic sites), that affect overall species health and abundance, as well as potential impacts (modify or destroy) to designated critical habitat. It should be noted that several species discussed in this report, are associated with the Virgin River, which is located more than 30 miles from the proposed withdrawal area. Species that are associated with the Virgin River are included in analysis because they are listed on the USFWS Mohave County Species threatened and endangered species list and groundwater (R-aquifer) from portions of the North Parcel are associated with the Virgin River watershed (see Section 3.4, Water Resources).

3.8.1 Threatened, Endangered, and Candidate Species

The Endangered Species Act of 1973, as amended, provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The law requires federal agencies, in consultation with the USFWS and/or the U.S. National Oceanic and Atmospheric Administration Fisheries Service, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. Table 3.8-1 summarizes general information on special status species and agency involvement and documents whether that species is analyzed in detail in Chapter 4.

In addition to threatened, endangered, and candidate species, this section also addresses species proposed for listing, species undergoing status review as potential candidates for listing, species covered under Conservation Agreements, and recently delisted species. The species listed in Table 3.8-2 and discussed below were based on review of the most recent USFWS species lists for Mohave and Coconino counties, Arizona, a search of the Arizona Heritage Data Management System and pertinent literature, correspondence with the USFWS, and meetings with the USFWS, NPS, Forest Service, and BLM. Table 3.8-2 contains 36 species that may be found within the proposed withdrawal area or adjacent to the proposed withdrawal area. Information on species trends (when available) and proximity to mining claims (when applicable) is included. The term ‘possible’ is defined as when a species has a high probability of occurring because documented habitat components are present or the species may exist in close proximity to the proposed withdrawal area.

Plants

BRADY PINCUSHION CACTUS (*PEDIOCACTUS BRADYI*)

The species is known to occur at several locations in House Rock Valley (Figure 3.8-1). Within House Rock Valley, the BLM currently administers the Marble Canyon ACEC (see Figure 3.6-1) for protection of the species (BLM 2008b). The Marble Canyon ACEC includes one of only two populations known to occur on public lands (BLM 2007). It is also the only area where the species overlaps Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*) (see below). The soils where Brady pincushion cactus occurs are derived from the Moenkopi Formation and characterized by overlying limestone chips. Trend studies have been conducted yearly since 1986 and show a stable population, with some fluctuations related to rodent depredation and precipitation (BLM 2007).

SENTRY MILKVETCH (*ASTRAGALUS CREMNOPHYLAX* VAR. *CREMNOPHYLAX*)

The plant is not known to occur within the proposed withdrawal area. *Astragalus* is the largest genus of flowering plants in Arizona. *Astragalus cremnophylax* and three other species are in the subsection *Humillimi* of *Astragalus* (Maschinski 1993). Sentry milk-vetch is a rare endemic plant known from only three locations on the South Rim of the Grand Canyon. All locations are within Grand Canyon National Park and are referred to as: Maricopa Point, Grandview, and Lollipop Point. Sentry milk-vetch is found where Kaibab limestone forms large flat platforms with shallow soils near pinyon-juniper woodlands. The species' habitat specificity, reduced number, vigor of plants, and small habitat size make it vulnerable to extinction. Given these conditions, the major threats to the species include limited number, distribution, and size of the populations; low reproduction; stochastic environmental or demographic events; and habitat destruction and modification (AGFD 2005a; USFWS 2006a).

Table 3.8-1. Special Status Species Summary

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Birds							
Bald eagle (*Haliaeetus leucocephalus*)	Yes	Yes	Delisted	Yes	Yes	No	Yes
California condor (*Gymnogyps californianus*)	Yes	Yes	Endangered with nonessential experimental 10(j) population within proposed withdrawal area	No	No	No	Yes
Mexican spotted owl (*Strix occidentalis lucida*)	Yes	Yes	Threatened w/CH in North Parcel	No	No	No	Yes
Southwestern willow flycatcher (*Empidonax traillii extimus*)	Possible	Yes	Endangered w/CH	No	No	No	Yes
Yuma clapper rail (*Rallus longirostrus yumanensis*)	No	Yes	Endangered w/o CH	No	No	No	Yes
American peregrine falcon (*Falco peregrinus anatum*)	Yes	Yes	Delisted	Yes	Yes	No	Yes
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Possible	Yes	Candidate	No	Yes	No	Yes
California least tern (*Sterna antillarum browni*)	No	No	Endangered w/CH	No	No	No	No See Table 4.8-1
Northern goshawk (*Accipiter gentilis atricapillus*)	Yes	Yes	No	Yes	Yes	No	Yes
Western burrowing owl (*Athene cunicularia hypugea*)	Yes	Yes	No	Yes	Yes	No	Yes
Ferruginous Hawk (*Buteo regalis*)	Yes	Yes	No	No	Yes	No	Yes
Golden Eagle (*Aquila chrysaetos*)	Yes	Yes	No	No	Yes	No	Yes
Pinyon Jay (*Gymnorphinus cyanocephalus*)	Yes	Yes	No	No	Yes	No	Yes
Mammals							
Greater western mastiff bat (*Eumops perotis californicus*)	Possible	Yes	No	Yes	Yes	Yes	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Mammals, continued							
Desert bighorn sheep (*Ovis canadensis nelsoni*)	Yes	Yes	No	Yes	No	No	Yes
Western red bat (*Lasiurus blossevillii*)	Possible	Yes	No	Yes	No	No	Yes
Spotted bat (*Euderma maculatum*)	Yes	Yes	No	Yes	Yes	Yes	Yes
Allen's lappet-browed bat (*Idionycteris phyllotis*)	Yes	Yes	No	Yes	Yes	Yes	Yes
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	Yes	Yes	No	Yes	Yes	Yes	Yes
Long-legged myotis (*Myotis volans*)	Yes	Yes	No	No	No	Yes	Yes
Big free-tailed bat (*Nyctinomops macrotis*)	Yes	Yes	No	No	No	Yes	Yes
Pocketed free-tailed bat (*Nyctinomops femorosaccus*)	Possible	Yes	No	No	No	Yes	Yes
Mexican long-tongued bat (*Choeronycteris mexicana*)	Possible	Yes	No	No	Yes	Yes	Yes
Southwestern myotis (*Myotis auriculus*)	No	Yes	No	No	No	Yes	Yes
Black-footed ferret (*Mustela nigripes*)	No	Yes	Endangered w/o CH	No	No	No	No See Table 4.8-1
Southwestern river otter (*Lontra canadensis sonora*)	No	Yes	No	No	No	Yes	No See Table 4.8-1
House Rock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*)	Yes	Yes	No	Yes	Yes	No	Yes
Merriam's shrew (*Sorex merriami*)	Yes	Yes	No	Yes	No	No	Yes
Mogollon vole (*Microtus mogollonensis*)	Yes	Yes	No	Yes	No	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Mammals, continued							
Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)*	No	No	Endangered w/o CH	No	No	No	No See Table 4.8-1
Arizona myotis (*Myotis occultus)*	No	Yes	No	No	Yes	No	Yes
Gunnison's prairie dog (*Cynomys gunnisoni*)	No	Yes	No	No	Yes	No	Yes
Plants							
Brady pincushion cactus (*Pediocactus bradyi*)	Yes	Yes	Endangered w/o CH	No	No	No	Yes
Jones cycladenia (*Cycladenia humilis* var. *jonesii*)	No	Yes	Threatened w/o CH	No	No	No	No See Table 4.8-1
Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*)	No	Yes	Endangered w/o CH	No	No	No	Yes
Siler pincushion cactus (*Pediocactus sileri*)	Yes	Yes	Threatened w/o CH	No	No	No	Yes
Welsh's milkweed (*Asclepia welshii*)	No	Yes	Threatened w/CH in Utah	No	No	No	No See Table 4.8-1
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	Yes	Yes	Candidate	No	Yes	No	Yes
Paradine (Kaibab) plains cactus (*Pediocactus paradinei*)	Yes	Yes	Conservation Agreement	No	Yes	No	Yes
Pipe Springs cryptantha (*Cryptantha semiglabra*)	Possible	Yes	No	No	Yes	No	No See Table 4.8-1
San Francisco Peaks groundsel (*Packera franciscana*)	No	No	Threatened w/CH	No	No	No	No See Table 4.8-1
Navajo Sedge (*Carex specuicola*)	No	No	Threatened w/CH	No	No	No	No See Table 4.8-1
Arizona cliffrose (*Purshia subintegra*)	No	No	Endangered w/o CH	No	No	No	No See Table 4.8-1

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Plants, continued							
Arizona bugbane (*Cimicifuga arizonica*)	No	No	Conservation Agreement	No	No	No	No See Table 4.8-1
Morton wild buckwheat (*Eriogonum mortonianum)*	Possible	Yes	No	Yes	No	No	Yes
Grand Canyon rose (*Rosa stellata* var. *abyssa*)	Yes	Yes	No	No	Yes	Yes	Yes
Marble Canyon milkvetch (*Astragalus cremnohylax* var. *hevronii*)	Yes	Yes	No	No	Yes	No	Yes
Mt. Trumbull beardtongue (*Penstemon distans*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Paria Plateau fishhook cactus (*Sclerocactus sileri*)	Yes	Yes	No	No	Yes	No	Yes
September 11 stickleaf (*Mentzelia memorabilis*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Silverleaf sunray (*Enceliopsis argophylla*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Sticky wild buckwheat (*Eriogonum viscidulum*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Gierisch mallow (*Sphaeralcea gierischii*)	No	Yes	Candidate	No	Yes	No	No See Table 4.8-1
Holmgren milkvetch (*Astragalus holmgreniorum*)	No	Yes	Endangered w/CH in Arizona and Utah	No	No	No	No See Table 4.8-1
Grand Canyon beavertail cactus (*Opuntia basilaris* var. *longiareolata*)	No	Yes	No	No	No	Yes	Yes
Kaibab agave (*Agave utahensis* ssp. *kaibabensis*)	No	Yes	No	No	No	Yes	Yes
McDougall's yellowtops (*Flaveria mcdougallii*)	No	Yes	No	No	No	Yes	Yes
Grand Canyon cave-dwelling primrose (*Primula specuicola*)	No	Yes	No	No	No	Yes	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Plants, continued							
Kaibab suncup (Grand Canyon evening-primrose) (*Camissonia specuicola* ssp. *hesperia*)	No	Yes	No	No	No	Yes	Yes
Arizona leatherflower (*Clematis hirsutissima* var. *hirsutissima*)	Yes	Yes	No	Yes	No	No	Yes
Tusayan flameflower (*Talinum validulum*)	Yes	Yes	No	No, but tracked as a rare species	No	No	Yes
Tusayan rabbitbrush (*Chrysothamnus molestus*)	Yes	Yes	No	Yes	No	No	Yes
Marble Canyon indigo bush (*Psorothamnus arborescens* var. *pubescens*)	Possible	Yes	No	No	Yes	No	Yes
Diamond Butte milkvetch (*Astragalus toanus* var. *scidulus*)	No	Yes	No	No	Yes	No	Yes
Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus*)	No	No	No	No	Yes	No	No See Table 4.8-1
Fish							
Apache trout (*Oncorhyncus gilae apache*)	No	No	Threatened w/o CH	No	No	No	No See Table 4.8-1
Humpback chub (*Gila cypha*)	No	Yes	Endangered w/CH–Colorado River	No	No	No	Yes
Razorback sucker (*Xyrauchen texanus*)	No	No	Endangered w/CH	No	No	No	Yes
Little Colorado spinedace (*Lepidomeda vittata*)	No	No	Threatened w/ CH	No	No	No	No See Table 4.8-1
Bonytail chub (*Gila elegans*)	No	No	Endangered w/ CH	No	No	No	No See Table 4.8-1
Roundtail chub (*Gila robusta*)	No	No	Candidate	No	Yes	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Fish, continued							
Flannelmouth sucker (*Catostomus latipinnis*)	No	Yes	No	No	Yes	Yes	Yes
Desert sucker (*Catostomus* [*Pantosteus*] *clarki*)	No	Yes	No	No	Yes	Yes	Yes
Speckled dace (*Rhinichthys osculus*)	Possible	Yes	No	No	Yes	No	Yes
Woundfin (*Plagopterus argentissimus*)	No	Yes	Endangered, w/CH along the Virgin River in Utah, Arizona, and Nevada	No	No	No	Yes
Virgin River chub (*Gila seminuda*)	No	Yes	Endangered w/CH along the Virgin River in Utah, Arizona, and Nevada	No	Yes	No	Yes
Virgin spinedace (*Lepidomeda mollispinis mollispinis*)	No	Yes	Conservation Agreement	No	Yes	No	Yes
Bluehead Sucker (*Catostomus discobolus*)			No	No	Yes	No	
Reptiles and Amphibians							
Relict leopard frog (*Lithobates* [*Rana*] *onca*)	No	No	Candidate with Conservation Agreement and Strategy	No	Yes	No	Yes
Northern leopard frog (*Lithobates* [*Rana*] *pipiens*)	Possible	Yes	No	Yes	Yes	No	Yes
Lowland leopard frog *(Lithobates* [*Rana*] *yavapaiensis*	No	Yes	No	Yes	Yes	No	Yes
Chiricahua leopard frog (*Lithobates* [*Rana*] *chiricahuensis*)	No	No	Threatened w/o CH	No	No	No	No See Table 4.8-1
Northern Mexican gartersnake (*Thamnophis eques megalops*)	No	No	Candidate	No	Yes	No	No See Table 4.8-1
Grand Canyon rattlesnake (*Crotalus oreganus abyssus*)	Possible	Yes	No	Yes	No	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Reptiles and Amphibians, continued							
Desert tortoise (*Gopherus agassizii*) (Mohave population)	No	No	Threatened w/CH	No	No	No	No See Table 4.8-1
Desert tortoise (*Gopherus agassizii*) (Sonoran population)	No	Yes	Candidate	No	Yes	Yes	No See Table 4.8-1
Invertebrates							
Kanab ambersnail (*Oxyloma. h. kanabensis*)	Possible	Yes	Endangered w/o CH	No	No	No	Yes
Grand Canyon cave pseudoscorpion (*Archeolarca cavicola*)	No	Yes	No	No	No	Yes	Yes
Hydrobiid spring snails Grand Wash springsnail (*Pyrgulopsis bacchus*) Desert springsnail (*Pyrgulopsis deserta*)	No	Yes	No	No	Yes	No	Yes
Succineid snails (all species in Family Succineidae), including Niobrara ambersnail (*Oxyloma haydeni haydeni*);	No	Yes	No	No	Yes	No	Yes

Sources: USFWS Species list for Coconino and Mohave counties was accessed on January 15, 2010, and again on August 15, 2010. Arizona Heritage Data Management System accessed on January 15, 2010; received data on January 20, 2010 (buffer set for proposed withdrawal area only); BLM (2010) list.

Note: CH = Critical habitat.

Table 3.8-2. Federally Listed Species and Their Potential for Occurrence in the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Brady pincushion cactus (*Pediocactus bradyi*)	USFWS E	No	Yes	No
Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*)	USFWS E	No	No	Yes
Holmgren milkvetch (*Astragalus holmgreniorum*)	USFWS E	No	No	No
Welsh's milkweed (*Asclepias welshii*)	USFWS T with Critical Habitat	No	No	No
Siler pincushion cactus (*Pediocactus sileri*)	USFWS T	Yes	No	No
Jones' cycladenia (*Cycladenia humilis* var. *jonesii*)	USFWS T	No	No	No
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	USFWS C BLM S	Yes	Yes	Possible
Paradine (Kaibab) plains cactus (*Pediocactus paradinei*)	USFWS CA BLM S	No	Yes	No*
Gierisch mallow (*Sphaeralcea gierischii*)	USFWS C BLM S	No	No	No
San Francisco Peaks groundsel (*Packera franciscana*)	USFWS T with Critical Habitat	No	No	No
Navajo Sedge (*Carex specuicola*)	USFWS T with Critical Habitat	No	No	No
Arizona cliffrose (*Purshia subintegra*)	USFWS E	No	No	No
Arizona bugbane (*Cimicifuga arizonica*)	USFWS Conservation Agreement	No	No	No
Wildlife				
Black-footed ferret (*Mustela nigripes*)	USFWS E	No	No	No
California condor (*Gymnogyps californianus*)	USFWS E	Yes	Yes	Yes
Southwestern willow flycatcher (*Empidonax traillii extimus*)	USFWS E with Critical Habitat	Possible	No	No
Yuma clapper rail (*Rallus longirostrus yumanensis*)	USFWS E	No	No	No
Mexican spotted owl (*Strix occidentalis lucida*)	USFWS T with Critical Habitat	Yes	Possible	Possible
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	USFWS C BLM S	Possible	No	No
California least tern (*Sterna antillarum browni*)	USFWS E	No	No	No
Desert tortoise (*Gopherus agassizii*) (Mojave population)	USFWS T with Critical Habitat	No	No	No
Desert tortoise (*Gopherus agassizii*) (Sonoran population)	USFWS C BLM S	No	No	No
Chiricahua leopard frog (*Lithobates* [Rana] *chiricahuensis*)	USFWS T	No	No	No

Table 3.8-2. Federally Listed Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Wildlife, continued				
Northern Mexican gartersnake (*Thamnophis eques megalops*)	USFWS C BLM S	No	No	No
Relict leopard frog (*Lithobates* [Rana] *onca*)	USFWS C with CA BLM S	No	No	No
Humpback chub (*Gila cypha*)	USFWS E with Critical Habitat	No	No	No
Razorback sucker (*Xyrauchen texanus*)	USFWS E with Critical Habitat	No	No	No
Virgin River chub (*Gila seminuda*)	USFWS E with Critical Habitat	No	No	No
Woundfin (*Plagopterus argentissimus*)	USFWS E with Critical Habitat	No	No	No
Apache trout (*Oncorhyncus gilae apache*)	USFWS T	No	No	No
Little Colorado spinedace (*Lepidomeda vittata*)	USFWS T with Critical Habitat	No	No	No
Bonytail chub (*Gila elegans*)	USFWS T with Critical Habitat	No	No	No
Roundtail Chub (*Gila robusta*)	USFWS C BLM S	No	No	No
Virgin spinedace (*Lepidomeda mollispinis mollispinis*)	CA BLM S	No	No	No
Kanab ambersnail (*Oxyloma haydeni kanabensis*)	USFWS E	No	Possible	No
Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)*	USFWS E	No	No	No

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

USFWS

C = Candidate. Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.

CA = Conservation Agreement. Formal agreement between the Forest Service and one or more parties to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened.

E = Listed Endangered: imminent jeopardy of extinction under ESA.

T = Listed Threatened: imminent jeopardy of becoming endangered under ESA.

* Adapted from Forest Service (2009a).

HOLMGREN MILKVETCH (*ASTRAGALUS HOLMGRENIORUM*)

The species does not occur within the proposed withdrawal area. Only three populations are known: one in Arizona and two in Washington County, Utah (USFWS 2010c). The primary population is in Mohave County, Arizona (see Figure 3.8-1), near the Virgin River Gorge. All populations are within 9 miles of St. George, Utah. Habitat for the species is shallow, sparsely vegetated soils derived primarily from the Virgin Limestone member of the Moenkopi Formation at 2,700 to 2,800 feet amsl. The number of living plants may not exceed 10,000 (Van Buren and Harper 2003). In drought years, populations are as much as 95% smaller than in years with adequate water.

WELSH'S MILKWEED (*ASCLEPIAS WELSHII*)

The species is not known to occur within the proposed withdrawal area. In Arizona, it occurs north of House Rock Valley along BLM Road 1065 (see Figure 3.8-1); it is also found in Utah north of the Kanab Plateau. It grows on open, sparsely vegetated, semi-stabilized sand dunes and on the lee slopes of actively drifting sand dunes. It is found in small numbers in Vermilion, scattered in the Navajo Sandstone derived Aeolian sand dunes of Coyote Buttes (BLM 2007). In the past, OHV activity was the main threat to this species, but it is now well protected as a result of the designation and management of the Paria Canyon–Vermilion Cliffs Wilderness Area, which encompasses the Coyote Buttes. Critical habitat is located entirely in Utah around Coral Pink Sand Dunes State Park. As denoted with designated critical habitat, this species is found on open, sparsely vegetated semi-stabilized coral pink sand dunes, in sagebrush, juniper, pine and oak communities of the Great Basin desertscrub, at 1,700–1,900 m amsl (AGFD 2005b). Populations of Welsh's milkweed apparently are stable. It is known from four locations, with a total of approximately 20,000 aboveground stems (AGFD 2005b).

SILER PINCUSHION CACTUS (*PEDIOCACTUS SILERI*)

Siler pincushion cactus occurs at several locations on the Kanab Plateau within the proposed withdrawal area (see Figure 3.8-1). Within the North Parcel, both the Johnson Spring and Moonshine Ridge ACECs (see Figure 3.6-1) were established in part to protect this cactus. Several of the known populations occur outside these two ACECs, including along BLM Road 5. The species is found exclusively on gypsiferous clay to sandy soils and appears to be strongly related to the Shnabkaib and middle red members of the Moenkopi Formation (BLM 2007). These soils are high in soluble salts.

Trend studies, first undertaken in the 1980s, demonstrate a relatively stable population with some fluctuations caused by precipitation and rodent depredations (BLM 2007). The species was downlisted to threatened in 1993 because it was later determined to be more abundant and widespread than was believed at the time of listing. Two mining claims are within the boundaries of known populations, and another 25 mining claims are within about 1,300 feet of known populations (Payne et al. 2010).

JONES' CYCLADENIA (*CYCLADENIA HUMILIS* VAR. *JONESII*)

The species is not known to occur within the proposed withdrawal area. Although its range is mostly in Utah, the species occurs in Arizona a few miles north of the Kanab Plateau (see Figure 3.8-1), just west of the Kaibab Indian Reservation in Potter Canyon and an adjacent canyon. The Lone Butte ACEC (see Figure 3.6-1) was established in part to protect this plant. In Arizona, it is found on gypsiferous, saline soils of the Chinle Formation (BLM 2007).

The population in Arizona appears to be well protected from threats resulting from private land and rugged terrain, which limit access. Trend studies have been undertaken at two plots and have shown a stable population with some precipitation-related fluctuations (BLM 2007).

FICKEISEN PLAINS CACTUS (*PEDIOCACTUS PEEBLESIANUS* VAR. *FICKEISENIAE*)

Fickeisen plains cactus occurs within the proposed withdrawal area (see Figure 3.8-1) (Forest Service 2009a). On the North Parcel, it occurs in areas between the canyon draining Kanab Creek, particularly on plateaus between Chamberlain, Hack, and Grama canyons, as well as along the Toroweap Road (BLM Road 109). On the East Parcel, the species occurs within the Marble Canyon ACEC, as well as along the western portion of House Rock Valley within and along the edge of Kaibab National Forest. The Coconino Rim portion of the Kaibab National Forest may contain habitat for the plant, but surveys of this habitat have not been conducted. It tends to occur in shallow soils derived from exposed layers of Kaibab Limestone (BLM 2007). After flowering and fruiting, the cactus retracts into the soil, making it difficult to locate. This cactus occurs in very small populations at several locations on the Arizona Strip.

Trend studies have been ongoing since the middle 1980s and show populations are relatively stable, with occasional fluctuations from precipitation and rodent depredation (BLM 2007). There are no mining claims within known Fickeisen plains cactus populations, but there are four claims within 1,300 feet of known plants (Payne et al. 2010).

PARADINE (KAIBAB) PLAINS CACTUS (*PEDIOCACTUS PARADINEI*)

The species is found within the proposed withdrawal area (see Figure 3.8-1) (Forest Service 2009a). Management considerations for this species is addressed through a Conservation Agreement dated February 11, 1998, and signed by the Forest Service, BLM, and USFWS. It occurs in fairly open, mostly level sites on alluvial fans, valley bottoms, and ridge tops where plants are preferentially associated with grass (blue grama) (AGFD 1999). It prefers soils with coarse fragments in conjunction with the Kaibab Limestone Formation (BLM 2007).

Populations were reported as declining on both BLM and Forest Service land (BLM 2007). A.M. Phillips. III and others (Phillips et al. 2001) conducted surveys on the North Kaibab Ranger District in 1992–1994 and found a fairly substantial population of scattered individuals in pinyon-juniper woodland. Field surveys in 2000–2001 (Frey 2001; Phillips et al. 2001) showed an apparent sharp decrease in the numbers of cacti since 1994, probably as a result of conditions caused by a drought from 1998 to the summer of 2000. In 2010 after a wet winter, Frye, B.G. Phillips, and others observed abundant flowering and fruiting in the monitoring plots that have been inventoried for over 20 years; recruitment was evident in 2011. Other observations at various locations in the spring of 2011 revealed numerous cacti, including young and old plants, where they have not been seen in abundance for over 10 years.

GIERISCH MALLOW (*SPHAERALCEA GIERISCHII*)

The species does not occur within any of the proposed withdrawal parcels. It is found in extreme northwestern Mohave County near the vicinity of Black Rock Gulch, Black Knolls, and Pigeon Canyon (AGFD 2005c). Habitat includes warm desert shrub community, mainly on gypsiferous outcrops of the Harrisburg Member of the Kaibab Formation as well as on the Moenkopi Formation (AGFD 2005c). Population trends are unknown (AGFD 2005c).

SAN FRANCISCO PEAKS GROUNDSEL (*PACKERA FRANCISCANA*)

The species does not occur within the proposed withdrawal area. This species is found in alpine tundra above southwestern spruce-fir or bristlecone pine (*Pinus aristata*) forests on talus slopes above 3,300 m (10,900 feet) amsl. The current range of this species includes San Francisco Peaks, Coconino County. Critical habitat has been established for this species and includes three alpine areas of Coconino National Forest (USFWS 2008).

NAVAJO SEDGE (*CAREX SPECUICOLA*)

This species does not occur within the proposed withdrawal area. This species is endemic to the Navajo Nation, Coconino, Navajo, Apache counties in Arizona and San Juan County in Utah (AGFD 2005d). Within northern Arizona, this species is known to occur from the Navajo Creek drainage in Coconino County, east to the Tsegi Canyon Watershed and the east side of Shonto Wash south of Shonto in Navajo County, south to the Rock Point/Mexican Water and Canyon de Chelly National Monument, Apache County (AGFD 2005d).

ARIZONA CLIFFROSE (*PURSHIA SUBINTEGRA*)

This species does not occur within the proposed withdrawal area. This species is endemic to Arizona. Within Arizona this species is found in Central Arizona near Horseshoe Lake, Maricopa County; near Cottonwood, Yavapai County; near Burro Creek, Mohave County; and near Bylas, Graham County (AGFD 2001a). Habitat includes rolling, rocky, limestone hills and slopes within Sonoran Desertscrub. This species requires white Tertiary (Miocene and Pliocene) limestone lakebed deposits high in lithium, nitrates, and magnesium (AGFD 2001a).

ARIZONA BUGBANE (*CIMICIFUGA ARIZONICA*)

This species does not occur within the proposed withdrawal area. This species is endemic to Arizona (AGFD 2008a). Within Arizona this species is found in Central Arizona near Bill Williams Mountain (Kaibab National Forest), tributaries to Oak Creek, and West Clear Creek (Coconino National Forest), Coconino County; Workman Creek and Cold Springs Canyon in the Sierra Ancha Mountains (Tonto National Forest), Gila County (AGFD 2008a).

Animals

BLACK-FOOTED FERRET (*MUSTELA NIGRIPES*)

The species does not occur within the proposed withdrawal area. In Arizona, it has been reintroduced into the Aubrey Valley in Coconino County (AGFD 2001b), where there are currently two populations: an experimental, nonessential population [10(j) status]; and a fully protected population located approximately 10 miles southwest of the Kaibab National Forest (Figure 3.8-2). There are no known colonies of Gunnison's prairie dogs (*Cynomys gunnisoni*), their main prey species, on the Kaibab National Forest large enough to support black-footed ferrets (Forest Service 2009a). Habitat includes arid prairies, the same habitat used by prairie dogs, the principal food source of the species.

HUALAPAI MEXICAN VOLE (*MICROTUS MEXICANUS HUALPAIENSIS*)

The species does not occur within the proposed withdrawal area and is endemic to Arizona. This species is known from Mohave County (Hualapai and Music Mountains, Grand Wash Cliffs, Wabayuma Peak vicinity, and upper Blue Tank Wash drainage), Coconino County (Prospect Valley, Laguna Valley, Aubrey Cliffs, Round Mountain, and Trinity Mountain), Yavapai County (Santa Maria and Santa Prieta mountains, and Walnut Creek vicinity, north of Bald Mountain) (AGFD 2003a). The Hualapai Mexican vole is primarily associated with woodland forest types containing grasses and grass-sedge associates and occurs in moist, grass-sedge habitats along permanent or semipermanent waters (such as springs or seeps), but may be able to occupy drier areas when grass/forb habitats are available, particularly during wetter years (AGFD 2003a). This species diet consists mainly of grasses, forbs, and other plants (AGFD 2003a).

CALIFORNIA CONDOR (*GYMNOGYPS CALIFORNIANUS*)

As of March 31, 2011, there are a total of 196 condors in the wild population, 68 of them in Arizona. Birds have only been released at Vermilion Cliffs (no releases at Hurricane Cliffs). Breeding activity has occurred at the locations mentioned, but not all these nests have been successful. Lead contamination from hunter-killed carcasses continues to be a major factor affecting the reintroduction program (personal communication, Brenda Smith, USFWS 2011). Critical habitat for this species occurs in California only. A reintroduction program began on the BLM's Arizona Strip District in 1996, with release sites on both the Vermilion Cliffs and the Hurricane Cliffs. This reintroduced population has been designated experimental, non-essential, as defined under Section 10(j) of the ESA. For ESA Section 7 purposes, the species is treated as a proposed species on BLM and Forest Service lands and as a threatened species on NPS lands. As of July 2009, there were 180 free-flying condors, 75 of which are found in Arizona (Payne et al. 2010). This species is a carrion feeder, usually on mammalian carcasses. Foraging for carrion occurs over long distances, as a condor can travel 80 to 160 km (48–96 miles) per day in search of food (USFWS 2001). It is highly attracted to human activity. Condors have been documented having successful breeding in the vicinity of the Vermilion Cliffs and east side of the Kaibab Plateau and within the Grand Canyon (Figure 3.8-3). The designated experimental population area in Arizona includes portions of Apache, Coconino, Mohave, Navajo, and Yavapai counties (USFWS 2001). Condors' diet consists of large, terrestrial mammalian carcasses such as deer, goats, sheep, donkeys, horses, pigs, cougars, bears, or cattle. Alternatively, they may feed on the bodies of smaller mammals, such as rabbits or coyotes (USFWS 2001).

SOUTHWESTERN WILLOW FLYCATCHER (*EMPIDONAX TRAILLII EXTIMUS*)

Southwestern willow flycatchers occur along the Colorado River in the Grand Canyon. The species is not known to occur in the proposed withdrawal area (Figure 3.8-4), and there is no critical habitat on the proposed withdrawal area (Figure 3.8-5). Critical habitat is located along the Virgin River and includes riparian areas dominated by native plants which can vary from single-species, single-layer patches to multi-species, multilayered strata with complex canopy and subcanopy structure. The southwestern willow flycatcher diet primarily consists of insects.

Habitat along Kanab Creek may be used during migration by flycatchers for resting and feeding. The BLM has identified two patches of suitable habitat along Kanab Creek (one at Clearwater Spring and the other 0.5 mile downstream from the spring) and several areas of potentially suitable habitat adjacent to Gunsight Point, but no willow flycatchers have been documented at any of these locations (BLM 2007). Willow-cottonwood habitat along Kanab Creek has been replaced largely by saltcedar which is also used by southwestern willow flycatchers. The Kanab Creek ACEC (see Figure 3.6-1), designated at 13,148 acres, was in part established for protection of the species (BLM 2008b).

Nesting sites have been identified in upper Grand Canyon near RMs 24, 28, 50, and 71 (Payne et al. 2010), as well as along the river corridor from Spencer Canyon/RM 246 (Payne et al. 2010) to Lake Mead National Recreation Area (RM 285.3) (McLeod et al. 2008). The locations of the canyon nesting areas are depicted in Figure 3.8.4.

The north-central limit of the breeding range for the species is southern Utah. Historically, it was recorded in southern Utah along the Virgin River (Phillips 1948; Wauer and Carter 1965), Colorado River and Kanab Creek (Behle 1985; Behle et al. 1958; Behle and Higgins 1959; Browning 1993), and perhaps the Paria River (BLM unpublished data, as cited in USFWS 2002b). Recent studies along the Virgin River in St. George have located resident and breeding individuals (Langridge and Sogge 1998; McLeod and Koronkiewicz 2010). According to the range-wide willow flycatcher database, Kanab Creek, in the town of Kanab, has been surveyed from 2000 to 2007, with two territories recorded in 2002 and none in other years (personal communication, S. Durst, USFWS 2010).

YUMA CLAPPER RAIL (*RALLUS LONGIROSTRUS YUMANENSIS*)

Yuma clapper rail is not known to occur within the proposed withdrawal area. The Yuma clapper rail occurs within the Virgin River drainage above Lake Mead (personal communication, Brenda Smith, USFWS 2011). It may also occur along the Virgin and Muddy rivers in Nevada near Lake Mead. Large populations are present on Bill Williams River, the lower Gila River from near Phoenix to the Colorado River, and along the lower Salt and Verde rivers. It prefers the tallest, densest cattail and bulrush (*Scirpus* sp.) marshes available (AGFD 2006b). Yuma clapper rail primarily eats crustaceans and mollusks.

MEXICAN SPOTTED OWL (*STRIX OCCIDENTALIS LUCIDA*)

There are no known Mexican spotted owl nesting records for any of the proposed withdrawal parcels; however, a portion of Kanab Creek, which has been included as critical habitat for this species, is located within the North Parcel. A total of 41 Protected Activity Centers (PACs) have been recorded in Grand Canyon National Park within the upper reaches of several large, steep-walled tributary side canyons (Payne et al. 2010). A PAC is delineated at known owl sites to encompass a minimum of 600 acres of the best nesting and roosting habitat at the site. One PAC, along Kanab Creek in Grand Canyon National Park, is immediately south of the Kanab Plateau, and numerous PACs in Grand Canyon National Park are immediately north of the Kaibab National Forest. Because of the proximity of known PACs and the fact that in Grand Canyon National Park the species forage in pinyon-juniper woodland and home ranges (n = 5 adult males) were larger than the PAC sizes recommended in the Recovery Plan (Bowden 2008), the species is considered likely to occur on all of the proposed withdrawal parcels while foraging or during post-nesting dispersal. According to Payne et al. (2010), the Grand Canyon National Park population may serve a critical role in connecting populations via juvenile dispersal. Based on habitat modeling in the canyon, the Park originally estimated that another 40 potential PACs could possibly be delineated. Most of those potential territories would probably be found in the lower gorge west of Powell Plateau.

Mexican spotted owl critical habitat includes dense old growth mixed-conifer forests located on steep slopes, especially deep, shady ravines (AGFD 2005e). These sites have high canopy closure, high basal area, many snags, and many downed logs. For foraging, multistoried forest with many potential patches is desirable. Mexican spotted owls nest and roost primarily in closed-canopy forests or rocky canyons. In the northern portion of the range (southern Utah and Colorado), most nests are in caves or on cliff ledges in steep-walled canyons (AGFD 2005e). The owl's diet consists of rodents, birds, lizards, insects, and occasionally bats (AGFD 2005e).

In the Colorado Plateau Recovery Unit, the ponderosa pine and pine-oak habitat are not considered nesting habitat for the species; only the mixed-conifer and riparian habitat types are considered nesting or roosting habitat, according to the *Mexican Spotted Owl Recovery Plan* (USFWS 1995a). The Forest Service has informed the BLM that there is no mixed-conifer habitat on the South Parcel. However, the USFWS considers the forested "canyon-like" habitat in the northeastern portion of the North Kaibab Ranger District to be potential nesting habitat unless surveys demonstrate otherwise. On the Kanab Plateau, there are 9,600 acres of designated critical habitat in the North Parcel (within Grama, Hack, Chamberlain, and Water canyons). The BLM considers upper Kanab Creek and the Hack Canyon area (including Grama, Water, and Chamberlain canyons) to be occupied, high-priority areas for the species (BLM 2008b:Appendix A). This determination is based entirely on the presence of habitat components; the area has not been surveyed. This habitat is within Critical Habitat Unit CP-10, which includes portions of the Arizona Strip, Kaibab National Forest, and Grand Canyon National Park (see Figure 3.8-5) (USFWS 2004).

The southeast corner of the Kanab Plateau is within Critical Habitat Unit CP-10, which includes portions of the Arizona Strip, Kaibab National Forest, and Grand Canyon National Park (see Figure 3.8-5) (USFWS 2004). All three proposed withdrawal parcels are within the Colorado Plateau Recovery Unit, one of six recovery units recognized in the United States (USFWS 1995a). The Colorado Plateau Recovery Unit coincides with the Colorado Plateau physiographic province and includes most of south-central and southern Utah, plus portions of northern Arizona, northwestern New Mexico, and southwestern Colorado.

YELLOW-BILLED CUCKOO (*COCCYZUS AMERICANUS OCCIDENTALIS*)

There are no yellow-billed cuckoo nesting records from within the proposed withdrawal area, but cuckoos have been recorded in Grand Canyon National Park (Payne et al. 2010) and may occur along Kanab Creek on the Kanab Plateau. The breeding range of the species is currently restricted to southern and central Arizona and the extreme northeast corner of the state (AGFD 2002a; Corman 2005). It has been observed in the Arizona Strip in the cottonwood/willow galleries at the confluence of Beaver Dam Wash and the Virgin River (BLM 2007). In Arizona, the species prefers streamside cottonwood, willow groves, and larger mesquite bosques for migrating and breeding (AGFD 2002a). Yellow-billed cuckoos feed almost entirely on large insects that they glean from tree and shrub foliage. They feed primarily on caterpillars, including tent caterpillars. They also feed frequently on grasshoppers, cicadas, beetles, and katydids, occasionally on lizards, frogs, and eggs of other birds, and rarely on berries and fruits.

CALIFORNIA LEAST TERN (*STERNA ANTILLARUM BROWNI*)

There are no occurrences of California least tern within the proposed withdrawal area, and the proposed withdrawal area does not fall within designated critical habitat for this species. The California least tern is primarily a resident of California but may occur in different parts of Arizona where habitat components are adequate for nesting or feeding such as large lakes, recharge basins, or wetland areas (USFWS 2009a). Breeding has been documented in Maricopa County. Transient migrants occur more frequently and have recently been documented in Mohave and Pima counties. This species forms nesting colonies on barren to sparsely vegetated areas and in shallow depressions on open sandy beaches, sandbars, gravel pits, or exposed flats along shorelines of inland rivers, lakes, reservoirs, and drainage systems (USFWS 2009a). The California least tern is diet is primarily a fish-eater, feeding in shallow waters of rivers, streams, and lakes (USFWS 2009a).

DESERT TORTOISE (*GOPHERUS AGASSIZII*) (MOJAVE POPULATION)

The proposed withdrawal area does not include desert tortoise habitat and does not fall within designated critical habitat for the species. There are no occurrences of desert tortoise within the proposed withdrawal area. In Arizona, tortoises and critical habitat are located north of the Colorado River, approximately 40 miles west of the North Parcel (see Figure 3.8-5). The Arizona Strip is within the Northeast Mojave Recovery Unit and includes two areas of critical habitat for the species: one along the western slope of the Beaver Dam Mountains (Beaver Dam Slope), the other along the northern slope of the Virgin Mountains (Gold Butte-Pakoon) (BLM 2007). Habitat for the species includes sandy 13 loam and rocky soils in valleys, bajadas, and rocky slopes and hills in the Mojave Desert at elevations ranging from 500 to 5,100 feet amsl (BLM 2007). The desert tortoise is an herbivore. Desert annuals, particularly forbs, are the primary food source for Mojave desert tortoise, and grasses are considered to be secondary in importance (Ernst and Lovich 2009).

DESERT TORTOISE (*GOPHERUS AGASSIZII*) (SONORAN POPULATION)

The Sonoran desert tortoise does not occur within the proposed withdrawal area. The distribution in the United States is considered to be east and south of the Colorado River, extending south and east from northwestern Mohave County (near Perce Ferry) in Arizona, and covers roughly the western portion of the state (AGFD 2001c). The distribution in the United States is likely bounded to the northeast and east by habitat changes imposed by the Mogollon Rim. Habitat consists primarily of rocky slopes and bajadas of the Mojave and Sonoran desertscrub vegetation communities (AGFD 2001c). The desert tortoise is an herbivore. Grasses form the bulk of its diet, but it also eats herbs, annual wildflowers, and new growth of cacti, as well as their fruit and flowers (AGFD 2001c).

RELICT LEOPARD FROG (*LITHOBATES* [RANA] *ONCA*)

The species does not occur within the proposed withdrawal area. In Arizona, extant populations apparently are restricted to two general areas: Surprise Canyon in lower Grand Canyon National Park and Sycamore Spring, both in Mohave County (USFWS 2009b). However, according to USFWS (personal communication, Brian Wooldridge, U.S. Fish and Wildlife Service 2009), the frogs in Surprise Canyon originally thought to be this species are actually lowland leopard frogs (*Rana yavapaiensis*). Relict leopard frog was introduced to Sycamore Spring in 2003. It also is present in Nevada at springs near the Overton Arm of Lake Mead and springs in Black Canyon below Hoover Dam (USFWS 2009b). No relict leopard frogs are known from BLM lands on the Arizona Strip (BLM 2007). A historic population was found at a privately owned spring adjacent to the Virgin River at Littlefield, Arizona, but that population has since been extirpated (BLM 2007). Adult frogs inhabit permanent streams, springs, and spring-fed wetlands below approximately 2,000 feet amsl (USFWS 2009b). Relict leopard frog presumably feed on a wide variety of invertebrates (USFWS 2009b).

In August 2009, 17 springs in Grand Canyon National Park considered at risk from uranium extraction activities were sampled for relict leopard frogs and other aquatic organisms by USGS and NPS personnel (Museum of Northern Arizona 2009). Relict leopard frogs were not found during this survey.

CHIRICAHUA LEOPARD FROG (*LITHOBATES* [RANA] *CHIRICAHUENSIS)*

This species does not occur within the proposed withdrawal area. This species inhabits mountain regions of central and southeastern Arizona, southwestern New Mexico, south in the Sierra Madre Occidental to Western Jalisco, Mexico, from 1,066–2,408 m (3,500–7,900 feet) amsl (AGFD 2006c). Within Arizona, this species’ range is divided into two areas. The first (northern population) extends from montane central Arizona east and south along the Mogollon Rim to montane parts of west-southwestern New Mexico. The second is located in the mountains and valleys south of the Gila River in southeastern Arizona and southwestern New Mexico and extends into Mexico (adjacent Sonora) along the eastern slopes of the Sierra Madre Occidental (AGFD 2006c). The primary habitat type of Chiricahua leopard frog is oak, mixed oak, and pine woodlands. Other habitat types range into areas of chaparral, grassland, and even desert.

Chiricahua leopard frogs are habitat generalists that live and breed in lentic and lotic habitats in natural and man-made systems (AGFD 2006c). The Chiricahua leopard frog presumably feeds on a wide variety of invertebrates as well as some small vertebrates (including juveniles of their own kind) (AGFD 2006c).

NORTHERN MEXICO GARTERSNAKE (*THAMNOPHIS EQUES MEGALOPS*)

This species does not occur within the proposed withdrawal area. Northern Mexico gartersnake ranges from southeastern Arizona and extreme southwestern New Mexico, southward into the highlands of western and southern Mexico, to Oaxaca (AGFD 2001d). Within Arizona, this species occurs in the southeast corner of state from the Santa Cruz Valley east and generally south of the Gila River. Recent valid records (post 1980) occur from the San Rafael and Sonoita grasslands area and from Arivaca. It is also known from the Agua Fria River, Oak Creek, the Verde River, and from several upper Salt/Black River sites, including smaller tributaries (AGFD 2001d). The gartersnake eats frogs, toads, fish, lizards, and small mammals (AGFD 2001d).

HUMPBACK CHUB (*GILA CYPHA*)

Humpback chub does not occur within the proposed withdrawal area, and there is no critical habitat for the species within the proposed withdrawal area; however, the Colorado River, which is adjacent to the proposed withdrawal area, has been designated critical habitat. Humpback chubs feed predominantly on small aquatic insects, diatoms and filamentous algae. According to USFWS biologist Glen Knowles (personal communication 2009), this species occurs in the lower 12 miles of the Little Colorado River, and from about RMs 30 to 240 in the main stem Colorado River; the vast majority of fish, however, are located in the lower 9 miles of the Little Colorado River and in the reach of the Colorado River around the Little Colorado River, from RMs 56 to 67 below Parker Dam and from the Paria River to Hoover Dam. Included in the critical habitat designation is the main stem Colorado River from the confluence of the Paria River to Hoover Dam, including Lake Mead, Lake Mohave, and Colorado River below Parker Dam. Critical habitat includes portions of the Colorado, Green, and Yampa rivers in the Upper Basin and the Colorado and Little Colorado rivers in the Lower Basin in Colorado, Utah, and Arizona (USFWS 2002a). Critical habitat relative to the proposed withdrawal area is depicted in Figure 3.8-5. According to NPS biologist Brian Healy (personal communication 2010), NPS is currently working on several translocation projects within the Grand Canyon. To date, Shinamu Creek has had two translocation efforts, with about 300 fish being released. Feasibility studies are underway to potentially translocate humpback chub to Bright Angel Creek and Havasu Creek, and long-range planning could translocate populations of humpback chub in Kanab Creek in later phases.

RAZORBACK SUCKER (*XYRAUCHEN TEXANUS*)

Razorback sucker does not occur within the proposed withdrawal area, and there is no critical habitat designated on any of the proposed withdrawal parcels. Currently, natural adult populations occur only in Lakes Mohave, Mead, and Havasu (AGFD 2002b). Critical habitat includes parts of the Yampa, Greene, Duchesne, White, Colorado, San Juan, Gila, Salt, and Verde rivers (USFWS 2009c). Included in the designation are Lake Mohave, Lake Mead, and the Colorado River below Parker Dam (see Figure 3.8-5). This species uses a variety of habitat types from main stem channels to slow backwaters of medium-sized and large streams and rivers, sometimes around cover (AGFD 2002b). Recent data indicate that razorback suckers have been found upstream of Lake Mead in the main stem of the Colorado River (personal communication, Pam Sponholtz, USFWS 2010). These records are important because they open up the possibility of razorback suckers’ being found throughout the Colorado River, especially during the time frame of this proposed withdrawal. The USFWS considered the Colorado River occupied habitat.

Historical records from the Grand Canyon through 1990, as reported by Minckley et al. (1991), are Bright Angel Creek, 1944 (one fish); Lees Ferry, 1963 (one fish); Paria River, 1978 (one fish); Paria River, 1979 (three fish); Bass Rapid, 1986 (one fish; photographed); Bright Angel Creek, 1987 (three fish); and mouth of the Little Colorado River, 1989 and 1990 (three fish each year).

All recent records of the species are from the Little Colorado River. According to the Grand Canyon Monitoring and Research Center database, which includes records through 2006, there are several records from the Little Colorado from 1989 through 1995. The diet of this species generally is composed of insects and planktonic food sources.

VIRGIN RIVER CHUB (*GILA SEMINUDA*)

The species does not occur within any of the proposed withdrawal parcels, and there is no critical habitat on any of the proposed withdrawal parcels (see Figure 3.8-5). It occurs in the Moapa River in Nevada and the main stem Virgin River in Arizona, Utah, and Nevada from Pah Tempe Springs downstream to the Mesquite Diversion in extreme northwestern Arizona (Mohave County) (USFWS 2009d). Only the Virgin River population is listed. Critical habitat includes the main stem Virgin River and its 100-year floodplain, extending from the confluence of La Verkin Creek, Utah, to Halfway Wash, Nevada (USFWS 2000). Habitat is deeper areas where waters are swift but not turbulent, generally where there are boulders or other cover (USFWS 2009d). The status of this fish is not well known at the present time, but it is likely to still occupy segments of the Virgin River. Virgin River chub are opportunistic feeders, consuming zooplankton, aquatic insect larvae, other invertebrates, debris, and algae.

WOUNDFIN (*PLAGOPTERUS ARGENTISSIMUS*)

Woundfin does not occur within the proposed withdrawal area, and there is no critical habitat in any of the proposed withdrawal parcels (see Figure 3.8-5). Critical habitat is identical to the designation for the Virgin River chub (USFWS 2000). Woundfin has been extirpated from almost all of its historical range, except the main stem Virgin River from Pah Tempe Springs to Lake Mead in northwestern Arizona (Mohave County) (USFWS 2009e). Habitat is shallow, warm, turbid, fast-flowing water (USFWS 2009e). Numbers are thought to be low in the Arizona portion of the Virgin River as a result of competition with introduced species for resources and the absence of suitable habitat features (BLM 2007). Woundfin diets are quite varied and consist mainly of insects, insect larvae, other invertebrates, algae, and detritus.

APACHE TROUT (*ONCORHYNCUS GILAE APACHE*)

The species does not occur within the proposed withdrawal area. The natural range is the headwater streams of the Salt (Black and White rivers), Little Colorado, and Blue rivers in the White Mountains of east-central Arizona (AGFD 2001e). It has been introduced and has become established outside its natural range in the Pinaleño Mountains, Coronado National Forest, and North Kaibab Ranger District of the Kaibab National Forest along North Canyon Creek (AGFD 2001e). In North Canyon Creek, records are all within the Saddle Mountain Wilderness (personal communication, Angela Gatto, Forest Service 2009). The Apache trout’s diet consists of both terrestrial and aquatic insects.

LITTLE COLORADO SPINEDACE (*LEPIDOMEDA VITTATA*)

The species does not occur within the proposed withdrawal area and is endemic to the Little Colorado River and its north-flowing tributaries, including the Arizona counties of Coconino, Navajo, and Apache (AGFD 2001f). Historical distribution is similar to the current distribution but may have occurred in the Zuni River watershed south of Gallup, New Mexico (AGFD 2001f). This species appears to be quite capable of tolerating relatively harsh environments that undergo dramatic fluctuations in pH, dissolved gases, and water temperature. Predation occurs mainly from rainbow trout (*Oncorhynchus mykiss*) and green sunfish (*Lepomis cyanellus*) (AGFD 2001f). The diet of Little Colorado River spinedace varies seasonally and consists primarily of aquatic and terrestrial insects.

BONYTAIL CHUB (*GILA ELEGANS*)

The species does not occur within the proposed withdrawal area. This species was once widely distributed throughout the Colorado River and its main tributaries, which include the Green River in Utah and Wyoming and the Colorado, Gila, Salt, and Verde rivers in Arizona (AGFD 2001g). Currently found only in isolated populations in the Yampa, Green, and Colorado rivers at the Colorado–Utah border and at the confluence of the Green and Colorado rivers. In the lower basin, found only in Lake Mohave with possible individuals between Parker and Davis dams. Critical habitat was established for bonytail chub in March, 1994 (AGFD 2001g), designating portions of the Colorado, Green, and Yampa rivers in the upper basin and the Colorado River from Hoover to Parker dams (including Lake Mohave and Lake Havasu) (AGFD 2001g). Bonytail chub are opportunistic feeders, eating insects, zooplankton, algae, and higher plant matter.

ROUNDTAIL CHUB (*GILA ROBUSTA*)

This species does not occur within the proposed withdrawal area. Roundtail chubs are known from larger tributaries of the Colorado Basin from Wyoming south to Arizona and New Mexico, as well as the Rio Yaqui south to Rio Piaxtla, northwestern Mexico (AGFD 2002c). Within Arizona, this species currently occurs in two tributaries of the Little Colorado River (Chevelon and East Clear Creeks); several tributaries of the Bill Williams River basin (Boulder, Burro, Conger, Francis, Kirkland, Sycamore, Trout, and Wilder Creeks); the Salt River and four of its tributaries (Ash Creek, Black River, Cherry Creek and Salome Creek); the Verde River and five of its tributaries (Fossil, Oak, Roundtree Canyon, West Clear, and Wet Beaver Creeks); Aravaipa Creek (a tributary of the San Pedro River); and Eagle Creek (a tributary of the Gila River) (AGFD 2002c). Roundtail chub eat terrestrial and aquatic insects, mollusks, other invertebrates, fishes, and algae.

VIRGIN SPINEDACE (*LEPIDOMEDA MOLLISPINIS MOLLISPINIS*)

This species does not occur within the proposed withdrawal area. Virgin spinedace is endemic to the Virgin River and its tributaries in Utah, Nevada, and Arizona (AGFD 2001h). Within Arizona, it is found in Mohave County, lower Beaver Dam Wash to its confluence with the Virgin River at Littlefield, Arizona. Historically present in the Virgin River from the Utah border to Littlefield, primarily in conjunction with clear water inflows of perennial tributaries (AGFD 2001h). Major factors affecting Virgin spinedace are water diversion, impoundment, channelization, degradation of water quality, and introduced species, both fishes and crayfish (AGFD 2001h). A Conservation Agreement between the USFWS, Utah Division of Wildlife Resources, Washington County Water Conservancy District, and others was finalized in 1995. The plan focuses on reducing threats to the Virgin spinedace and enhancing and/or stabilizing instream flow in specific reaches of occupied and unoccupied habitat. Virgin spinedace are opportunistic feeders, eating insects, insect larvae, other invertebrates, and plant matter.

KANAB AMBERSNAIL (*OXYLOMA HAYDENI KANABENSIS*)

Kanab ambersnail does not occur within any of the proposed withdrawal parcels. There are two populations in Arizona: Vasey's Paradise and Elves Chasm, both in Grand Canyon National Park (see Figure 3.8-4). There also are two populations in Utah along Kanab Creek (AGFD 2001j). The snails at Elves Chasm were introduced by AGFD. Vasey's Paradise is a naturally occurring population located approximately 32 miles downstream of Lees Ferry (USFWS 1995b), just south of House Rock Valley. Preliminary estimates indicated a population of about 16,000 individuals at this site (USFWS 1995b). In August 2009, 15 springs (including Vasey's Paradise) in Grand Canyon National Park were sampled for Kanab ambersnails by USGS and NPS personnel (Museum of Northern Arizona 2009). Kanab ambersnail was found at Vasey's Paradise, but no Kanab or other *Oxyloma* ambersnail shells or live individuals were found at any of the other springs visited. The snail also occurs at two wetlands located about 1.3 miles apart near the Arizona border in Kane County, Utah: Three Lakes Canyon and Kanab Creek Canyon (USFWS 1995b). Survey records from approximately 10 years ago indicate that one of the two Kanab Creek populations may be lost, apparently from cattle grazing (AGFD 2001j). Habitat is marshes watered by springs and seeps at the base of sandstone cliffs or limestone at approximately 3,200 feet amsl (AGFD 2001j).

3.8.2 Bureau of Land Management Sensitive Species

The BLM Sensitive species are listed in Table 3.8-3. All federal candidate species are considered and managed as BLM sensitive species (BLM 2010). Information on species trends is included with the individual species accounts when available.

In addition to BLM Sensitive species, Table 3.8-3 also contains species that the Forest Service and NPS also consider Sensitive or MIS, which means some species are listed by multiple agencies. These species are addressed only once and not repeated in Sections 3.8.3 or 3.8.4. Species included on both Forest Service and BLM sensitive species lists include Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*), western burrowing owl (*Athene cunicularia hypugea*), bald eagle (*Haliaeetus leucocephalus*), American peregrine falcon (*Falco peregrines anatum*), northern goshawk (*Accipiter gentilisatricapillus*), northern leopard frog (*Lithobates* [Rana] *pipiens*), and lowland leopard frog (*Lithobates* [Rana] *yavapaiensis*). Species included on BLM, Forest Service and NPS sensitive species lists include greater western mastiff bat (*Eumops perotis californicus*), spotted bat (*Euderma maculatum*), Allen's lappet-browed bat (*Idionycteris phyllotis*) and pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*). Species included on both BLM and NPS sensitive species lists include Grand Canyon rose (*Rosa stellata* var. *abyssa*), flannelmouth sucker (*Catostomus latipinnis*), desert sucker (*Catostomus* [Pantosteus] *clarki*) and Mexican long-tongued bat (*Choeronycteris Mexicana*).

Table 3.8-3. BLM Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Mt. Trumbull beardtongue (*Penstemon distans*)	BLM S	No	No	No
Grand Canyon rose (*Rosa stellata* ssp. *abyssa*)	BLM S NPS SC	Yes	No	Possible*
Marble Canyon milkvetch (*Astragalus cremnohylax* var. *hevronii*)	BLM S	No	Yes	No
Paria Plateau fishhook cactus (*Sclerocactus sileri*)	BLM S	No	Yes	No
September 11 stickleaf (*Mentzelia memorabilis*)	BLM S	No	No	No
Silverleaf sunray (*Enceliopsis argophylla*)	BLM S	No	No	No
Sticky wild buckwheat (*Eriogonum viscidulum*)	BLM S	No	No	No
Pipe Springs cryptantha (*Cryptantha semiglabra*)	BLM S	Possible	No	No
Marble Canyon indigo bush (*Astragalus cremnophlax* var. *hevronii*)	BLM S	No	Possible	No
Toana milkvetch/Diamond Butte milkvetch (*Astragalus toanus* var. *scidulus*)	BLM S	Possible	No	No
Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus*	BLM S	No	No	No
Animals				
Allen's lappet-browed bat (*Idionycteris phyllotis*)	BLM S Forest Service S NPS SC	Yes	Yes	Possible
Northern leopard frog (*Lithobates* [Rana] *pipiens*)	BLM Forest Service S	Possible	Possible	No

Table 3.8-3. BLM Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Animals, continued				
Lowland leopard frog *(Lithobates* [Rana] *yavapaiensis)*	BLM S Forest Service S	Possible	No	No
Bald eagle (*Haliaeetus leucocephalus*)	BLM S Forest Service S	Yes	Yes	Yes
American peregrine falcon (*Falco peregrinus anatum*)	BLM S Forest Service S	Yes	Possible	Possible
Northern goshawk (*Accipiter gentilis atricapillus*)	BLM S	Possible	Possible	Yes
Townsend's big-eared bat (*Corynorhinus townsendii*)	BLM S	Yes	Yes	Yes
Arizona myotis (*Myotis occultus*)	BLM S	Possible	Possible	Possible
Spotted bat (*Euderma maculatum*)	BLM S	Yes	Yes	Yes
Greater western mastiff bat (*Eumops perotis californicus*)	BLM S	Possible	Possible	Possible
Mexican long-tongued bat (*Choeronycteris mexicana*)	BLM S	Possible	Possible	Possible
Gunnison's prairie dog (*Cynomys gunnisoni*)	BLM S	No	No	Possible
Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*)	BLM S Forest Service S	No	Yes	No
Western burrowing owl (*Athene cunicularia hypugea*)	BLM S Forest Service S	Yes	Yes	No
Ferriginous Hawk (*Buteo regalis*)	BLM S	Possible	Possible	Possible
Golden Eagle (*Aquila chrysoides*)	BLM S	Yes	Yes	Possible
Pinyon jay (*Gymnorhinus cyanocephalus*)	BLM S	Yes	Yes	Yes
Flannelmouth sucker (*Catostomus latipinnis*)	BLM S NPS SC	No	No	No
Desert sucker (*Catostomus* [Pantosteus] *clarki*)	BLM S NPS SC	No	No	No
Speckled dace (*Rhinichthys osculus*)	BLM S	Possible	No	No
Bluehead sucker (*Catostomus discobolus)*	BLM S	Yes	Yes	Yes
Hydrobiid spring snails Grand Wash springsnail (*Pyrgulopsis bacchus*) Desert springsnail (*Pyrgulopsis deserta*)	BLM S	No	No	No
Succineid snails (F. Succineidae), Niobrara ambersnail (*Oxyloma haydeni haydeni*)	BLM S	No	No	No

Notes:

BLM
S = Sensitive: those taxa occurring on BLM Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service
S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)
SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

* Based on Forest Service (2009a).

Plants

MT. TRUMBULL BEARDTONGUE (*PENSTEMON DISTANS*)

Mt. Trumbull beardtongue does not occur within the proposed withdrawal area; however, it is known to occur approximately 20 miles southwest of the Kanab Plateau (see Figure 3.8-1). It is found at the southeastern edge of the Shivwits Plateau in Whitmore, Parashant, and Andrus canyons (AGFD 2001k). The species tends to be widely scattered in isolated populations that seem to be restricted to the relatively cool, moist microhabitats on north- and east-facing slopes of the Kaibab and Toroweap limestone formations (BLM 2007).

Population trends are unknown but apparently stable (AGFD 2001jk). The BLM initiated trend studies in 1987 and 1989 at two locations in Grand Canyon-Parashant National Monument (BLM 2007). By 1997, a large plot of 49 plants had increased in number to 80. The smaller count plot started with 21 plants in 1987, decreased to six in 1992, and increased to nine plants in 1997.

GRAND CANYON ROSE (*ROSA STELLATA* SSP. *ABYSSA*)

This species is listed by both the BLM and NPS. The species occurs within the proposed withdrawal area (see Figure 3.8-1). It also occurs along the rim (mainly North Rim, Twin Point) of the Grand Canyon and at the junction of the Little Colorado River and Big Canyon (AGFD 2005f). All known populations are in the Timoweap member of the Moenkopi Formation, on or near canyon rims or the tops of cliffs at the edges of mesas or plateaus, as well as along low ledges at depressions caused by breccia pipes (BLM 2007; Brian 2000). The Kanab Canyon population is decreasing; trends at Twin Point are unknown (AGFD 2005f).

TOANA MILKVETCH/DIAMOND BUTTE MILKVETCH (*ASTRAGALUS TOANUS* VAR. *SCIDULUS*)

The species is found outside the proposed withdrawal area approximately 10 miles west of the Kanab Plateau (see Figure 3.8-1). It is known only from the bases of Diamond Butte and Twin Buttes, where it grows on small outwash fans by small mesas on alluvium overlying the Shnabkaib member of the Moenkopi Formation (BLM 2007).

Population trends are unknown. Less than 12 plants were first discovered in 1999 at two Arizona Strip sites (BLM 2007). These sites have been subsequently monitored, but no plants have been located.

MARBLE CANYON MILKVETCH (*ASTRAGALUS CREMNOHYLAX* VAR. *HEVRONII*)

The plant is found on the eastern edge of House Rock Valley (see Figure 3.8-1). It is endemic to the rim of Marble Canyon, where it occurs south of Shinumo Wash, north to Sheep Springs Wash (AGFD 2005g). Marble Canyon milkvetch occurs on rim-rock benches at the canyon edge in crevices and depressions with shallow soils on Kaibab Limestone at approximately 5,420 feet amsl (Arizona Rare Plant Committee 2001). Population trends are unknown (AGFD 2005g). In 1997, six sites with about 265 plants were located.

PARIA PLATEAU FISHHOOK CACTUS (*SCLEROCACTUS SILERI*)

The species occurs in House Rock Valley (East Parcel) and the Paria Plateau (north of the East Parcel) (Arizona Rare Plant Committee 2001). Habitat is sandstone to sandy soil of the Moenave, Chinle, and Navajo formations, where it grows on pinyon-juniper mesa tops at 5,000 to 6,300 feet amsl (Arizona Rare

Plant Committee 2001). Population trends are not well known (AGFD 2003b). This plant is difficult to locate in the field; it appears to be quite rare.

SEPTEMBER 11 STICKLEAF (*MENTZELIA MEMORABILIS*)

The species is found outside the proposed withdrawal area on the adjacent west lands (the Kanab Plateau) (see Figure 3.8-1). It is an Arizona endemic in northern Mohave County, in the Clayhole Wash drainage between Colorado City and Mount Trumbull (AGFD 2006d). September 11 stickleaf grows on dry gypsum-clay outcrops with sparse vegetation between 4,689 and 5,197 feet amsl (AGFD 2006d). Population trends are unknown (AGFD 2006d).

SILVERLEAF SUNRAY (*ENCELIOPSIS ARGOPHYLLA*)

Silverleaf sunray is found outside the proposed withdrawal area on the adjacent west lands (the Kanab Plateau). It is found in Mohave County in the vicinity of Lake Mead, the Grapevine Mesa area, below Hurricane Cliffs, south of Hoover Dam, the Boulder Dam area, the Gyp Hills area, and east of Littlefield (AGFD 2005h). Habitat consists of warm desert shrub communities on dry clay and gypsum slopes and in sandy washes (AGFD 2005h). Population trends are unknown (AGFD 2005h).

STICKY WILD BUCKWHEAT (*ERIOGONUM VISCIDULUM*)

The species does not occur within any of the proposed withdrawal parcels. It is found in extreme northwestern Mohave County (see Figure 3.8-1), north of the Virgin River (AGFD 2005i). Habitat includes low dunes, washes, and sandy flats and slopes in saltbush and creosote bush communities in Mohave Desertscrub (AGFD 2005i). Population trends are unknown (AGFD 2005i). There are reports of 29 occurrences in Nevada, with a total estimated population of at least 29,000 individuals.

PIPE SPRINGS CRYPTANTHA (*CRYPTANTHA SEMIGLABRA*)

The species is found outside the proposed withdrawal area north of the Kanab Plateau in extreme northwestern Coconino County and adjacent extreme northeastern Mohave County, in the area surrounding the town of Fredonia, Arizona (AGFD 2004a). All known localities are within 7 miles of Fredonia, and the type location is 2 miles east of Fredonia. It is found in the arid red detrital clay soils and gray shales of the Moenkopi Formation in the Great Basin Desertscrub biotic community at elevations ranging from 4,600 to 4,900 feet amsl (AGFD 2004a). Trends in populations are unknown (AGFD 2004a). This species appears to be tolerant of disturbance. A positive 90-day finding was published in the *Federal Register* (74[158]:41649–41662) for the Pipe Springs cryptantha and a 12-month status review to determine whether or not to federally list the species will be published in the future.

MARBLE CANYON INDIGO BUSH (*PSOROTHAMNUS ARBORESCENS VAR. PUBESCENS*)

The species is found outside the proposed withdrawal area but located on adjacent lands in the vicinity of Marble Canyon (Roth 2008). Marble Canyon indigo bush is endemic to Northern Coconino County, Arizona, in the vicinity of Marble Canyon and on the Navajo Nation (Roth 2008). This species is located on soils derived from the Moenkopi Formation in mixed desert shrub communities between 3,400 and 4,900 feet (Roth 2008).

THREE-CORNERED MILKVETCH (*ASTRAGALUS GEYERI VAR. TRIQUETRUS*)

The species is found outside the proposed withdrawal area in northwestern Mohave County, Arizona. The total range of this species is northwestern Arizona and southeastern Nevada (AGFD 2004f). This species is an ephemeral annual that is not seen for years at a time and prefers average to above-average rainfall years to germinate (AGFD 2004f). This species is limited to washes and small pockets of wind-deposited sand, of the creosote bush scrub series, with sandy soils formed from sedimentary formations adjacent to Lake Mead and its tributary valleys (AGFD 2004f). Within Arizona, this species is known from Sand Hollow Wash, Horsethief Canyon, and Beaver Dam Wash, Mohave County and located within an elevation from 2,000 and 2,395 ft (AGFD 2004f).

Animals

ALLEN'S LAPPET-BROWED BAT (*IDIONYCTERIS PHYLLOTIS*)

This species is included on the BLM, Forest Service, and NPS species lists. This insectivorous bat species has been recorded within the Kanab Plateau and House Rock Valley (AGFD 2010a). It is considered likely to occur on the Kaibab National Forest. Population status along the Colorado River corridor is unknown, but individuals have been observed and collected in the river corridor in Grand Canyon National Park (Payne et al. 2010). Most Arizona specimens have been taken from the southern Colorado Plateau, the Mogollon Rim, and adjacent mountain ranges (AGFD 2001g). In Arizona, it has been taken most often in ponderosa pine, pinyon-juniper woodland, and riparian areas with sycamores, cottonwoods, and willows (AGFD 2001g). Population trends are very poorly known (AGFD 2001g).

ARIZONA MYOTIS (*MYOTIS OCCULTUS*)

This insectivorous bat species is known to occur in Northern Arizona. Arizona distribution records do not contain information regarding whether this species is known to occur within the proposed withdrawal area (AGFD 2011). The total range for this species includes southern California, Arizona, New Mexico, and Colorado, south to Mexico and possibly into west Texas (AGFD 2011). This species has been observed at higher elevations in Apache, Coconino, Cochise, Gila, Greenlee, Mohave, Navajo, and Yavapai counties. Their elevation ranges from 3,200 to 8,620 feet; there are also records from much lower elevations between 150 and 1,000 feet along the lower Colorado River (AGFD 2011).The AGFD suggests this species may use manmade structures for roosting, but based on radio tracking studies performed in northern Arizona, maternity colonies were frequently observed in large ponderosa pine snags. They may use tree cavities, mines, or possibly caves for winter hibernation (AGFD 2011).

GREATER WESTERN MASTIFF BAT (*EUMOPS PEROTIS CALIFORNICUS*)

The insectivorous bat species is known to occur on adjacent lands to the proposed withdrawal area (AGFD 2010a). It is considered likely to occur on the South Parcel. It has been recorded in Grand Canyon National Park (Payne et al. 2010); sonograms recorded at Point Sublime on the North Rim of the Grand Canyon were verified by D. Pearson (AGFD 2002d). In Arizona, where it is considered a year-round resident, the species been found in all Arizona counties except Yavapai, Navajo, Apache, and Santa Cruz (AGFD 2002d). Habitat includes lower and upper Sonoran Desertscrub vegetation zones near cliffs, where it prefers rugged, rocky canyons with abundant crevices (AGFD 2002d). Population trends are poorly known (AGFD 2002d).

SPOTTED BAT (*EUDERMA MACULATUM*)

The insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a; Forest Service 2008a, 2009c). The Kaibab National Forest records are from the Camp 36 Tank (Forest Service 2008a, 2009c). It has been recorded from the Kaibab Plateau, at a watershed southeast of Seligman, at a known roost near Marble Canyon (AGFD 2003h), and in Grand Canyon National Park (Payne et al. 2010). There appears to be a substantial population in the Fort Pierce Wash area on the

Utah–Arizona border (AGFD 2003h). In Arizona, it is mostly collected in dry, rough desertscrub, with a few captured or heard in ponderosa pine forest (AGFD 2003h).

Population abundance and densities are very poorly known, but spotted bat is now known to occupy a wider total range and to be more common than initially thought (AGFD 2003h). The Fort Pierce Wash area of southwestern Utah and northwestern Arizona is one of five areas in the western United States where it has been taken in some numbers or fairly regularly (AGFD 2003h).

MEXICAN LONG-TONGUED BAT (*CHOERONYCTERIS MEXICANA*)

The species may occur on lands adjacent to the proposed withdrawal area. The AGFD documented one record along the Colorado River adjacent to East Parcel (AGFD 2006e). At Grand Canyon National Park, this species has also been documented living in caves and mines (Payne et al. 2010). The species prefers mesic areas in canyons of mixed oak-conifer forests in mountains rising from the desert (AGFD 2006e). Population trends are unknown (AGFD 2006e). This species of bat feed on fruits, pollen, nectar, and probably insects.

PALE TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII PALLESCENS*)

The insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a; Forest Service 1999, 2009c). Maternity colonies are located in the East and South parcels (AGFD 2010a). In the South Parcel, the species was identified during surveys of caves (Forest Service 2008b) and abandoned mine features (Forest Service 2008c). It is considered widespread in Arizona and has been found in Cochise, Coconino, Gila, Graham, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, and Yuma counties (AGFD 2003i). There is a maternity colony at Stanton's Cave in Grand Canyon National Park (Payne et al. 2010). Habitat includes desertscrub, oak woodlands, pinyon-juniper, and conifer forest types throughout the state in summer (AGFD 2003i).

HOUSEROCK VALLEY CHISEL-TOOTHED KANGAROO RAT (*DIPODOMYS MICROPS LEUCOTIS*)

This species is included on both the BLM and Forest Service species lists. The species is known to occur within the proposed withdrawal area (see Figure 3.8-2). The range is restricted to the House Rock Valley (East Parcel), on the west side of the Colorado River, in Coconino County (AGFD 2001l). Habitat is shrub-dominated Great Basin Desertscrub with relatively high shrub cover and sparse grass cover at 3,500 to 6,500 feet amsl. The preferred soils have a rocky or gravelly component and are deep to moderately deep (AGFD 2001l). The diet of this species is generally dominated by leaves, but it will sometimes eat insects and fungi (AGFD 2001l).

The relative abundance of the species throughout the occupied portion of East Parcel appears to be low and generally patchy; approximately 73,624 acres of habitat are occupied out of a total of about 150,000 acres that are available (AGFD 2001l). It appears that this species is now absent from part of its former range (AGFD 2001l).

WESTERN BURROWING OWL (*ATHENE CUNICULARIA HYPUGEA*)

This species is included on both the BLM and Forest Service sensitive species lists. The owl occurs on both the North and East parcels (AGFD 2001m). There are no known or historic records from the Kaibab National Forest. It occurs locally in open areas, generally year-round, with only a few winter records on the Colorado Plateau in the northeastern part of the state (AGFD 2001m).

Habitat includes open, well-drained grasslands, steppes, deserts, prairies, and agricultural lands, often associated with burrowing mammals. Burrowing owls feed on a wide variety of prey, changing food habits as location and time of year determine availability. Large arthropods, mainly beetles and grasshoppers, form a large portion of their diet. Small mammals, especially mice, rats, gophers, and ground squirrels, are also important food items. Other prey animals include reptiles and amphibians, scorpions, young cottontail rabbits, bats, and birds, such as sparrows and horned larks (AGFD 2001m).

BALD EAGLE (*HALIAEETUS LEUCOCEPHALUS*) (DELISTED)

The species has been documented within all three proposed withdrawal area. According to Payne et al. (2010), it is frequently observed over the South Parcel and has been observed roosting near Boggy Tank. - Bald eagles arrive in northern Arizona as early as the last week of October and typically leave by the third week of March (Payne et al. 2010). Bald eagles are mostly fish eaters. Bald eagles do nest in northern Arizona but have not been recorded from within the proposed withdrawal area (Brown and Stevens 1992). The bald eagle has been delisted under the ESA, which means that is no longer listed as threatened or endangered under the ESA.

AMERICAN PEREGRINE FALCON (*FALCO PEREGRINUS ANATUM*) (DELISTED)

Based on examination of the peregrine falcon nest map in the Arizona Heritage Data Management System (AGFD 2002e), the species appears to nest along Kanab Creek on the Kanab Plateau. There also are at least six peregrine falcon breeding territories along Marble Canyon (Payne et al. 2010), as well as breeding records along the Vermilion Cliffs immediately adjacent to the proposed withdrawal area (Figure 3.8-6) (AGFD 2002e). Currently, there are more than 50 nesting pairs in Grand Canyon National Park, from Lees Ferry to Lake Mead, and a monitoring program is in place (Payne et al. 2010). Optimum peregrine habitat is generally considered to be steep, sheer cliffs overlooking woodlands, riparian areas, or other habitats supporting abundant avian prey species (AGFD 2002e).

FERRUGINOUS HAWK (*BUTEO REGALIS*)

Ferruginous hawk is considered likely to occur within the proposed withdrawal area. In Arizona, this species prefers open scrublands and woodlands, grasslands, and Semidesert Grassland (AGFD 2001n). In general, the Ferruginous hawk breeds in open areas with little topographic relief and avoids high elevation, forest interior and narrow canyons. Hunting areas are typically open grasslands, preferably those dotted with suitable low hills or short trees which serve as perches (AGFD 2001n).

This species is primarily found in the western states of North America, southern Canada and down into central Mexico. Breeds form western Canada south to northern Arizona and New Mexico. The winter range is primarily from central Mexico north through the southwestern and mid-western United States. As discussed by AGFD (2001n) within Arizona this species breeds in northern Arizona on the Colorado Plateau and can be seen in virtually any part of Arizona with open environs, particularly in agricultural fields and native grasslands.

GOLDEN EAGLE (*AQUILA CHRYSAETOS*)

Golden eagle is considered likely to occur within the proposed withdrawal area. This species is usually found in open country, in prairies, arctic and alpine tundra, open wooded country and barren areas, especially in hilly or mountainous regions. They nest on rock ledges, cliffs or in large trees. In Arizona they are found in mountainous areas and are virtually vacant after breeding in some desert areas (AGFD 2002f). The Golden eagle’s territory size in several areas of the western United States averaged 22 to 55 square miles (57–142 sq km). The Golden eagle is a carnivore that feeds mainly on small mammals like rabbits, marmots, and ground squirrels. They may also eat insects, snakes, birds, juvenile ungulates, and carrion (AGFD 2002f).

NORTHERN GOSHAWK (*ACCIPITER GENTILIS ATRICAPILLUS*)

Northern goshawk is known to occur within the proposed withdrawal area (Figure 3.8-7).The Kaibab Plateau exhibits one of the highest breeding densities known (AGFD 2003k). In Arizona, the species nests most commonly in ponderosa pine forests along the Mogollon Rim and on the Kaibab Plateau and in ponderosa pine forests in the southeastern mountains (AGFD 2003k). Beier (1997) found that adult goshawks in Arizona wintered in ponderosa pine forest and pinyon-juniper woodlands during some winters. In general, females remained in ponderosa pine in the general vicinity of their nest, while most male goshawks moved 5 to 10 miles from the nesting area and generally into the closest pinyon-juniper woodlands.

Human disturbance is not considered a potential limiting factor (Reynolds et al. 2006). A number of the known goshawk nest sites on the Tusayan and Williams ranger districts of the Kaibab National Forest are located close to Level 2 forest roads, which are characterized by relatively low traffic volumes and speeds. Logging trucks passing within approximately 1,600 feet of two active nests on the Kaibab Plateau did not cause discernible behavioral responses from the individuals at the nests (Forest Service 2009d).

Little historical information on goshawk densities exists, but populations appear to have undergone dramatic declines over the past 50 years (AGFD 2003k). On the Kaibab National Forest, the species is assumed by the Forest Service to be declining (Forest Service 2008d). All ponderosa pine and ponderosa pine–Gambel oak habitat on the forest was surveyed by Forest Service personnel, following Forest Service regional northern goshawk protocol. A total of 107 nesting territories was identified on a 684-square-mile study area on the Kaibab Plateau from 1991 to 1996 (AGFD 2003k). Causes being investigated for the decline include a change in forest composition and structure resulting from intensive forest management between the 1960s and early 1990s, combined with catastrophic fire and wind throw and natural environmental variation in prey abundance (Bratland et al. 2008).

PINYON JAY (*GYMNORHINUS CYANOCEPHALUS*)

The pinyon jay occurs throughout much of the western United States. The pinyon jay can be found from central Oregon and Montana south to central Arizona, New Mexico and northwestern Oklahoma (Utah Division of Wildlife Resources 2011). Pinyon jays do not migrate and are typically found on dry mountain slopes and foothills near pinyon-juniper forests. This species can also be found in sagebrush, scrub oak, and chaparral communities and in pine forests. Pinyon jays live in large flocks that can have as many as 500 birds. A pinyon jay may spend its entire life in the flock it was born into. The pinyon jay population varies depending on the availability of pinyon pine seeds. In years when there aren't many seeds, the jay population drops. Each flock has an established home range, but may become somewhat nomadic and move long distances when food is scarce. The diet of the pinyon jay consists primarily of pinyon and other pine seeds, but also includes berries, small seeds, grains, and insects. At times, pinyon jays may also eat bird eggs and hatchlings (Utah Division of Wildlife Resources 2011).

FLANNELMOUTH SUCKER (*CATOSTOMUS LATIPINNIS*)

This species is included on both the BLM and NPS species lists. The flannelmouth sucker does not occur within the proposed withdrawal area; however, its range does include the Colorado River and its larger tributaries in Glen and Grand canyons, to include the Virgin River (AGFD 2001o). It is reportedly found in the Paria River at its confluence with the Colorado River (BLM 1987); however, this reference may no longer be accurate. Flannelmouth suckers are omnivorous, benthic foragers (they feed on the bottom) that are primarily restricted to large and moderately large rivers; larvae inhabit shallow, slow-flowing near-shore areas (AGFD 2001o).

DESERT SUCKER (*CATOSTOMUS* [PANTOSTEUS] *CLARKI*)

This species is included on both the BLM and NPS species lists. The species does not occur within the proposed withdrawal area. The range of this sucker in Arizona includes the lower Colorado River downstream of Grand Canyon National Park, generally including the Bill Williams, Salt, Gila, and San Francisco river drainages, along with the Virgin River basin (AGFD 2002g). Habitat consists of the rapids and flowing pools of streams and rivers, primarily over bottoms of gravel-rubble, with sandy silt in the interstices (AGFD 2002g). Young desert suckers feed primarily on the larvae of aquatic insects. Adults feed mostly on aquatic plants and parts of plants present along the stream bottom. Feeding is performed predominantly by scraping plant materials off of rocks and small stones (AGFD 2002g).

SPECKLED DACE (*RHINICHTHYS OSCULUS*)

Speckled dace is not known to occur within the proposed withdrawal area; however, it may occur in Kanab Creek on the Kanab Plateau (adjacent lands). In Arizona, it is found in the Colorado, Bill Williams, and Gila river drainages; it is not present in the slower and warmer portions of Colorado River main stem (AGFD 2002h). It is reportedly found in the Paria River at the confluence with the Colorado River (BLM 1987); however, this reference may no longer be accurate. The species is a bottom dweller, found in rocky riffles, runs, and pools of headwaters, creeks, and small to medium-sized rivers (AGFD 2002h). Populations of this species apparently are stable (AGFD 2002h). Speckled dace are benthic feeders, eating primarily insect larvae and other invertebrates, although algae and fish eggs are also consumed (AGFD 2002h).

BLUEHEAD SUCKER (*CATOSTOMUS DISCOBOLUS*)

The bluehead sucker is found in high gradient streams of western North America (AGFD 2003l).
The bluehead sucker is a benthic (bottom dwelling) species with a mouth modified to scrape algae (the primary food of the bluehead sucker) from the surface of rocks. Members of the species spawn in streams during the spring and summer. Fast-flowing water in high-gradient reaches of mountain rivers has been identified as important habitat for bluehead sucker.

In Arizona, this species is found in the Colorado River main stem and Grand Canyon tributaries, including Little Colorado River, Clear Creek, Bright Angel Creek, Shinumo Creek, Kanab Creek, and Havasu Creeks; rare below Diamond Head. This species may also be found in a few areas on the Navajo Reservation and in the San Juan Drainage (AGFD 2003l). This species is located within the proposed withdrawal area (Kanab Creek).

HYDROBIID SPRING SNAILS: GRAND WASH SPRINGSNAIL (*PYRGULOPSIS BACCHUS*); DESERT SPRINGSNAIL (*PYRGULOPSIS DESERTA*)

Neither of these *Pyrgulopsis* springsnails occurs within the proposed withdrawal area. Both species are associated with springs. The Grand Wash springsnail is known to occur in only three springs in the Grand Wash trough in Mohave County; the species possibly also occurs in the Virgin Mountains in Clark County, Nevada (BLM 2007). Desert springsnail is found in springs along the Virgin River in southwestern Utah and northwestern Arizona (BLM 2007). Population trends and food habits for these two snails are unknown (AGFD 2001p, 2004b).

SUCCINEID SNAILS (FAMILY SUCCINEIDAE): NIOBRARA AMBERSNAIL (*OXYLOMA HAYDENI HAYDENI*)

Niobrara ambersnail does not occur within the proposed withdrawal area. In Arizona, there are two populations along the Colorado River (see Figure 3.8-4): within the Grand Canyon at Indian Gardens

(Bright Angel Trail); and a riverside marsh at 9 Mile in the Lees Ferry reach (AGFD 2004c). The latter site is immediately adjacent to the East Parcel. In August 2009, 17 springs in Grand Canyon National Park considered at risk from uranium extraction activities were sampled for ambersnails by USGS and NPS personnel (Museum of Northern Arizona 2009). No *Oxyloma* snails were found during this survey. A third population of Niobrara ambersnails is located in southern Utah in the Kanab Canyon area (AGFD 2004c). The Indian Gardens population is restricted to permanently wet areas fed by a small spring, and the Lees Ferry population is restricted to areas with damp or saturated soil (AGFD 2004c).

Because of the populations' great reliance on wetland habitat, de-watering is a common threat to all *Oxyloma* populations (AGFD 2004c). The population near Lees Ferry is subject to inundation from even moderate flows of the Colorado River (>25,000 cubic feet per second [708 cubic meters per second]), and more than 90% of the entire habitat is inundated at 45,000 cubic feet per second or more (AGFD 2004c). The Indian Gardens population is threatened by trampling from off-trail hikers, large flash floods, and possible habitat loss/degradation as a result of landscape maintenance (AGFD 2004c).

3.8.3 Forest Service Sensitive Species

The Forest Service Sensitive species listed in Table 3.8-4 and addressed below are based on correspondence from Kaibab National Forest biologists and on the Regional Forester's sensitive species list (Forest Service 2010a). Information on species trends is included when available. As noted in Table 3.8-4, several of these species are also listed as sensitive by BLM and as such are addressed in Section 3.8.3, above. Species included on both Forest Service and BLM sensitive species lists include Houserock Valley chisel-toothed kangaroo rat, western burrowing owl, bald eagle, American peregrine falcon, northern goshawk, northern leopard frog, and lowland leopard frog.

Table 3.8-4. Forest Service Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Tusayan flameflower (*Phemeranthus validulum*)	Tracked as rare by Forest Service	No	No	Yes
Arizona leatherflower (*Clematis hirsutissima* var. *hirsutissima*)	Forest Service S	No	No	Yes
Tusayan rabbitbrush (*Chrysothamnus molestus*)	Forest Service S	No	No	Yes
Morton wild buckwheat (*Eriogonum mortonianum*)	Forest Service S	Possible	No	No
Animals				
Bald eagle (*Haliaeetus leucocephalus*)	BLM S Forest Service S (see species account in Section 3.8.2)	Yes	Yes	Yes
American peregrine falcon (*Falco peregrinus anatum*)	BLM S Forest Service S (see species account in Section 3.8.2)	Yes	Possible	Possible
Greater western mastiff bat (*Eumops perotis californicus*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Possible

Table 3.8-4. Forest Service Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Animals, continued				
Western red bat (*Lasiurus blossevillii*)	Forest Service S	Possible	Possible	Possible
Spotted bat (*Euderma maculatum*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Yes
Allen's lappet-browed bat (*Idionycteris phyllotis*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Yes
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Yes
Desert bighorn sheep (*Ovis canadensis nelsoni*)	Forest Service S	Yes	Yes	No
Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*)	BLM S Forest Service S (see species account in Section 3.8.2)	No	Yes	No
Merriam's shrew (*Sorex merriami*)	Forest Service S	No	Possible	Yes
Mogollon vole (*Microtus mogollonensis*)	Forest Service S	No	No	Yes
Northern goshawk (*Accipiter gentilis*)	BLM S Forest Service S Forest Service MIS (see species account in Section 3.8.2)	Possible	Possible	Yes
Western burrowing owl (*Athene cunicularia hypugea*)	BLM S Forest Service S (see species account in Section 3.8.2)	Yes	Yes	No
Lowland leopard frog *(Lithobates* [*Rana*] *yavapaiensis*	Forest Service S	Possible	No	No
Northern Leopard Frog (*Lithobates* [*Rana*] *pipiens*)	BLM S Forest Service S (see species account in Section 3.8.2)	Possible	No	No
Grand Canyon rattlesnake (*Crotalus oreganus abyssus*)	Forest Service S	Possible	No	No

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service

MIS = Management Indicator Species: Species managed by the Forest Service because they 1) are thought to be the easiest species for determining population trends; 2) best lend themselves to interpretations of population change relative to habitat condition; and 3) best lend themselves to interpretations of species mix relative to habitat conditions.

S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)

SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

Plants

TUSAYAN FLAMEFLOWER (*PHEMERANTHUS VALIDULUM*)

The species is found within the proposed withdrawal area (see Figure 3.8-1). It has been reported on the TenX and Kotzin inholdings (Forest Service 1999). The overall range includes several discrete locales: Pine Flats and vicinity, Tusayan, Coconino Plateau, Kaibab Plateau, southeast of Williams, the southern boundary of Grand Canyon National Park, near Grand Canyon Caverns, Rattlesnake Tanks near the San Francisco Mountains in Coconino County, Juniper Mountains, Big Black Mesa, and Black Hills, Yavapai County (AGFD 2002i). Habitat consists of shallow pockets of sandy soil on exposed bedrock ledges and terraces in Madrean pine-oak forest openings at 5,000 to 7,000 feet amsl (Arizona Rare Plant Committee 2001). There is no information on population trends (AGFD 2002i). Surveys conducted in the 1990s resulted in the discovery of 130 populations totaling more than 15,000 plants (Forest Service 1999).

ARIZONA LEATHERFLOWER (*CLEMATIS HIRSUTISSIMA* VAR. *HIRSUTISSIMA*)

Arizona leatherflower is found within the proposed withdrawal area (see Figure 3.8-1). In Arizona, it is known from the Flagstaff area along Rio de Flag and lower Lake Mary, Volunteer Canyon in the Tusayan, and the Chuska Mountains (Arizona Rare Plant Committee 2001). It occurs in moist mountain meadows, prairies, and open woods and thickets, usually in limestone soils of ponderosa pine and mixed-conifer forests at elevations ranging from 6,800 to 9,000 feet amsl (Arizona Rare Plant Committee 2001).

TUSAYAN RABBITBRUSH (*CHRYSOTHAMNUS MOLESTUS*)

Tusayan rabbitbrush occurs within the proposed withdrawal area (see Figure 3.8-1). In Arizona, it is generally found in the southern part of the South Parcel (Forest Service 1999). The overall range of the species includes Coconino County from the South Rim of Grand Canyon National Park to the Flagstaff area (AGFD 2005j). Two disjunct populations are present on the Navajo Nation (Hopi Buttes and west of Gray Mountain) (AGFD 2005j). It is typically found in open pinyon-juniper grasslands on slopes and flats (where periodic fires naturally occur at an interval of every 15–30 years) from 5,710 to 6,880 feet amsl (AGFD 2005j). Population trends are unknown (AGFD 2005j). It apparently is extant at 21 locations in Coconino County, Arizona; few to none of these locations are protected (see AGFD 2005j).

MORTON WILD BUCKWHEAT (*ERIOGONUM MORTONIANUM*)

The species is not known to occur within the proposed withdrawal area. It is found about 4 to 6 miles southwest of Fredonia along SR 389in, Mohave County (AGFD 2001q). It is also found approximately 9 miles east-northeast of Pipe Springs in Utah. Habitat is usually along small drainages in red clay hills of very shallow gypsiferous soils on sandstone and shale uplands (AGFD 2001q). Only one population, with approximately 750 plants, is known in Arizona (AGFD 2001q). The population appears to be stable, with several size and age classes represented. A positive 90-day finding was published in the *Federal Register* (74[240]:66866) for the Morton wild buckwheat, and a 12-month status review to determine whether or not to federally list the species will be published in the future.

Animals

WESTERN RED BAT (*LASIURUS BLOSSEVILLII*)

The insectivorous bat species is considered likely to occur within the proposed withdrawal area. It resides in Arizona from April through September, primarily in riparian and other woodland habitats where roosting sites are located in the foliage of trees and shrubs (AGFD 2003m). The species has been documented in Grand Canyon National Park, where it is found throughout the river corridor and has been observed and collected at various locations from Bright Angel Creek to Diamond Creek (Payne et al. 2010). Population trends are unknown in Arizona (AGFD 2003m).

DESERT BIGHORN SHEEP (*OVIS CANADENSIS NELSONI*)

Desert bighorn sheep occur within the proposed withdrawal area (Figure 3.8-8). There are two major habitat areas in the vicinity of the proposed withdrawal area: Kanab Creek and the Paria Canyon–Vermilion Cliffs Wilderness (BLM 2007). Desert bighorn sheep occur along the entire drainage of the Colorado River within Grand Canyon. This species preferred habitat is rough, rocky, sparsely vegetated land, characterized by steep slopes, canyons, and washes (Payne et al. 2010).

With the exception of occasional sightings, bighorn sheep were believed to have been eliminated from the above-listed major habitat areas around the turn of the century. In a cooperative effort between the BLM and AGFD beginning in 1979, it was successfully reintroduced, and populations in these areas now appear stable (BLM 2007). For example, bighorn sheep transplanted to the Paria Canyon–Vermilion Cliffs area (immediately north of House Rock Valley) beginning in 1984 have exhibited one of the best reproductive success rates of any bighorn transplant in Arizona, primarily because of desirable habitat conditions (BLM 2007).

MERRIAM'S SHREW (*SOREX MERRIAMI*)

Merriam's shrew is likely to occur within the proposed withdrawal area (Hoffmeister 1986). The distribution range in Arizona includes the Coconino Plateau, the Mogollon Plateau in the vicinity of Williams and Flagstaff, and Rose Peak in the White Mountains (Hoffmeister 1986). In Arizona, it inhabits cool, grassy locations near coniferous forests (Hoffmeister 1986). Merriam's shrew is widespread, although uncommon, and the population does not appear to be in decline (International Union for Conservation of Nature 2010). Merriam's shrews are insectivores, eating insects, insect larvae (such as caterpillars), worms, and other small invertebrates (Utah Division of Wildlife Resources 2010a).

MOGOLLON VOLE (*MICROTUS MOGOLLONENSIS*)

The species occurs within the proposed withdrawal area (Frey and LaRue 1993). The distribution range is primarily Arizona and New Mexico, with peripheral populations in Utah, Colorado, and Texas. It is confined mainly to montane areas, where it prefers grassy habitats in ponderosa pine and mixed-conifer forests (Frey and LaRue 1993). Mogollon voles are herbivores that eat mainly green vegetation (Utah Division of Wildlife Resources 2010b).

Population trends are unknown (AGFD 2003a), primarily as a result of taxonomic confusion. Recent genetic studies place *M. mexicanus hualpaiensis*, which was listed by the USFWS as endangered in 1987, in *M. mogollonensis*. *M. mogollonensis* is now believed to consist of three subspecies: *hualpaiensis*, *mogollonensis*, and *navaho* (AGFD 2003a).

GRAND CANYON RATTLESNAKE (*CROTALUS OREGANUS ABYSSUS*)

The Grand Canyon rattlesnake possibly occurs within the proposed withdrawal area (Stebbins 1985). This snake is a subspecies of the western rattlesnake and is found in extreme northwestern Arizona. It occurs in a variety of biotic communities, inhabits steep, rocky canyons, rolling hills, high plains, and plateaus of the upper Grand, Marble, Glen, and associated side canyons, as well as on the Arizona Strip, and eats small mammals.

3.8.4 National Park Service Species of Concern

The NPS Species of Concern listed in Table 3.8-5 and addressed below are those species that occur in close proximity to the proposed withdrawal area or that may be affected by one of the alternatives. This list is based on correspondence with Grand Canyon National Park biologists and uses the species given in Payne et al. (2010). Information on species trends is included when available. NPS Species of Concern are former USFWS Category 1, 2, and 3 species (USFWS no longer maintains a list of these species). Species included on both BLM and NPS sensitive species lists include Grand Canyon rose, flannelmouth sucker, desert sucker and Mexican long-tongued bat. As noted in Table 3.8-5, several of these species are also listed as sensitive by the BLM and/or the Forest Service and as such are discussed in either Section 3.8.2 or 3.8.3.

Table 3.8-5. NPS Sensitive Species and Their Potential for Occurrence on the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Grand Canyon rose (*Rosa stellata* ssp. *abyssa*)	BLM S NPS SC (see species account in Section 3.8.2)	Yes	No	Possible*
Grand Canyon beavertail cactus (*Opuntia basilaris* var. *longiareolata*)	NPS SC	No	No	No
Kaibab agave (*Agave utahensis* ssp. *kaibabensis*)	NPS SC	No	No	No
McDougall's yellowtops (*Flaveria mcdougallii*)	NPS SC	No	No	No
Grand Canyon cave-dwelling primrose (*Primula specuicola*)	NPS SC	No	No	No
Kaibab suncup (Grand Canyon Evening-primrose) (*Camissonia specuicola* ssp. *hesperia*)	NPS SC	No	No	No
Animals				
Grand Canyon cave pseudoscorpion (*Archeolarca cavicola*)	NPS SC	No	No	No
Mexican long-tongued bat (*Choeronycteris mexicana*)	BLM S NPS SC	Possible	Possible	Possible
Southwestern myotis (*Myotis auriculus*)	NPS SC	No	No	No
Southwestern river otter (*Lontra canadensis sonora*)	NPS SC	No	No	No
Allen's lappet-browed bat (*Idionycteris phyllotis*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Possible	Yes
Long-legged myotis (*Myotis volans*)	NPS SC (see species account in Section 3.8.4)	Yes	Possible	Yes
Pocketed free-tailed bat (*Nyctinomops femorosaccus*)	NPS SC (see species account in Section 3.8.4)	Possible	Possible	Possible
Greater western mastiff bat (*Eumops perotis californicus*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Possible	Possible

Table 3.8-5. NPS Sensitive Species and Their Potential for Occurrence on the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Spotted bat (*Euderma maculatum*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Yes
Big free-tailed bat (*Nyctinomops ferorosaccus*)	NPS SC (see species account in Section 3.8.4)	Yes	Yes	Possible
Allen's lappet-browed bat (*Idionycteris phyllotis*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Yes
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Yes
Flannelmouth sucker (*Catostomus latipinnis*)	BLM S NPS SC (see species account in Section 3.8.2)	No	No	No
Desert sucker (*Catostomus* [Pantosteus] *clarki*)	BLM S NPS SC (see species account in Section 3.8.2)	No	No	No

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service

S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)

SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

* Based on Forest Service (2009a).

Plants

GRAND CANYON BEAVERTAIL CACTUS (*OPUNTIA BASILARIS* VAR. *LONGIAREOLATA*)

This cactus variety is not known to occur within the proposed withdrawal area. The range in Arizona is apparently confined to Granite Rapids, Grand Canyon National Park, where it is found on rocky soils at the bases of talus slopes at about 2,000 feet amsl (Benson 1982; Brian 2000). According to Benson (1982), the validity of this variety is dubious. The elongate areoles that the specific epithet implies are not at all characteristic for *Opuntia basilaris* var. *longiareolata* and are sometimes found on plants of other varieties (eFloras 2010).

KAIBAB AGAVE (*AGAVE UTAHENSIS* SSP. *KAIBABENSIS*)

Kaibab agave is not known to occur within the proposed withdrawal area. It is endemic to Coconino and Mohave counties, Arizona, including the Kaibab Plateau south to the South Rim and along the cliffs above the Little Colorado River (AGFD 2005k). In Grand Canyon National Park, it is known from eastern Grand Canyon to the Kanab Plateau. Small populations occur in Virgin Canyon above the Virgin Gorge and in Lime Kiln Canyon, Mohave County (AGFD 2005k). Habitat is open ledges, rims, and level to moderately sloping ledges of limestone and sandstone-derived soils (Brian 2000) in the Mohave and Great Basin Desertscrub and Great Basin Conifer Woodland. It has been collected on the Esplanade

Formation and on Coconino Sandstone just above the Supai Formation (AGFD 2005k). Population trends are unknown (AGFD 2005k).

MCDOUGALL'S YELLOWTOPS (*FLAVERIA MCDOUGALLII*)

The species is not known to occur within the proposed withdrawal area. It is known from a limited number of populations along the tributaries and main Colorado River corridor of western Grand Canyon National Park, from Matkatimiba Canyon to Lava Falls Rapid, in Coconino and Mohave counties (AGFD 2005k; Arizona Rare Plant Committee 2001). It grows in hanging gardens or terrace ledges in perennial alkaline or saline seeps, in Muav Limestone and at the Muav Limestone Bright Angel Shale interface from 1,700 to 2,000 feet amsl (AGFD 2005k). The species is considered locally abundant within its limited habitat (NatureServe 2005).

GRAND CANYON CAVE-DWELLING PRIMROSE (*PRIMULA SPECUICOLA*)

The species is not known to occur within the proposed withdrawal area. In Arizona, it is endemic to the canyons of the Colorado River in Coconino and Mohave counties, including Grand Canyon National Park (AGFD 2004d). It grows in moist sites from hanging gardens or alcoves in canyons with limestone cliffs from 3,500 to 5,200 feet amsl in Utah and from 1,250 to 7,600 feet amsl in Arizona (AGFD 2004d). Populations appear to be stable (AGFD 2004d). In 1979, there were 10 estimated populations, with few to several hundred individuals per population (see AGFD 2004d).

KAIBAB SUNCUP (GRAND CANYON EVENING-PRIMROSE) (*CAMISSONIA SPECUICOLA* SSP. *HESPERIA*)

The species is not known to occur within the proposed withdrawal area. There are two disjunct populations along the Colorado River in Arizona, in Havasu and Hualapai canyons, Coconino County, and from Separation Canyon to Spencer Canyon, Mohave County (AGFD 2004e; Brian 2000). It is found scattered on open slopes and in rock crevices, washes, and dry streambeds, often on limestone at 1,240 to 4,500 feet amsl (AGFD 2004e). Population trends are unknown (AGFD 2004e).

Animals

GRAND CANYON CAVE PSEUDOSCORPION (*ARCHEOLARCA CAVICOLA*)

The species is not known to occur within the proposed withdrawal area. The only known location is along the Colorado River at Cave of the Domes, Grand Canyon National Park, Arizona (AGFD 2003n), about 5 miles north of the Kaibab National Forest. However, Payne et al. (2010) reference several specimens confirmed in two caves in the Lower Gorge. It is found in subterranean cave habitat with bats and/or rodents (AGFD 2003n). Population trends are unknown (AGFD 2003n).

SOUTHWESTERN MYOTIS (*MYOTIS AURICULUS*)

The insectivorous bat species is not known to occur within the proposed withdrawal area. According to Payne et al. (2010), this species has been captured once along the Colorado River in Grand Canyon National Park. It is found primarily in Gila, Maricopa, and Cochise counties (AGFD 2003o). Although typically found in ponderosa pine habitat and other semi-arid woodland habitats, it is also sometimes captured in desert grasslands (AGFD 2003o). Populations appear to be stable, although few data exist throughout the species' range (AGFD 2003o). It may be expanding its range northward in the United States.

SOUTHWESTERN RIVER OTTER (*LONTRA CANADENSIS SONORA*)

The native subspecies of river otter is not known to occur within the proposed withdrawal area. It is probably extirpated from its former range along the Colorado River (Payne et al. 2010). Although there are occasional unconfirmed sightings of otters along the Colorado River below Lake Mead, it is likely that these are a nonnative subspecies introduced into the river drainage by AGFD between 1978 and 1991 (Payne et al. 2010). A river otter subspecies from Louisiana, *L. c. lataxina*, was successfully introduced into the Verde River drainage in central Arizona during 1981–1983 and may eventually cause genetic swamping of any native individuals, if any still exist (AGFD 2002j).

Although apparently never abundant, the southwestern river otter population has declined and is now considered very rare by AGFD (AGFD 2002j). Evidence cited above also suggests the possibility of inbreeding between native, if any still exist, and introduced otters.

LONG-LEGGED MYOTIS (*MYOTIS VOLANS*)

This species is included on both the BLM and NPS species lists. According to the distribution map at AGFD (2003f) and information from Forest Service (2008a, 2009c), this insectivorous bat species has been recorded within the North and South parcels. The Kaibab National Forest records are from the PIPO Snag Roost, Camp 36 Tank, and Mile and a Half Tank (Forest Service 2008a, 2009c). It is considered likely to occur on East Parcel. Long-legged myotis is found in forested mountains in Apache, Cochise, Coconino, Gila, Mohave, and Yavapai counties (AGFD 2003f) and has been collected along the Colorado River corridor in Grand Canyon National Park (Payne et al. 2010). Although primarily a coniferous forest bat, it may also be found in riparian and desert habitats (AGFD 2003f). Populations are considered stable in Arizona (AGFD 2003f).

BIG FREE-TAILED BAT (*NYCTINOMOPS MACROTIS*)

This insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a). It is considered likely to occur within the South Parcel. It is widely spread throughout the state but is probably absent from coniferous Mogollon Plateau (AGFD 2003g). It is primarily an inhabitant of rugged, rocky country and riparian areas (AGFD 2003g). Populations appear to be stable, although not common, except sometimes locally (AGFD 2003g).

POCKETED FREE-TAILED BAT (*NYCTINOMOPS FEMOROSACCUS*)

This insectivorous bat species is considered possible within the proposed withdrawal area. It was collected in Grand Canyon National Park for the first time in 2002 near RM 209 (Payne et al. 2010). The range is otherwise limited primarily to the south half of Arizona in Pima, Gila, Mohave, Maricopa, La Paz, Pinal, Graham, Cochise, and Yuma counties (AGFD 2003j).

3.8.5 Arizona Game and Fish Department Species of Greatest Conservation Need

The AGFD has statutory authority and obligation under the ARS for fish and wildlife management in the state, including the proposed withdrawal area, except within Grand Canyon National Park. This statutory obligation includes management of both game and non-game wildlife. In cooperation with the AGFD, BLM and Forest Service develop management plans for wildlife species and habitats (BLM 2007). Many of the management directions for wildlife included in these habitat management plans are based on statewide goals of the AGFD in managing particular species. The BLM and Forest Service management plans include construction and maintenance of habitat improvement projects, primarily water developments for big- and small-game species, but many non-game species benefit from these projects as well. Other habitat enhancement projects implemented include prescribed burns, seeding, and chemical or mechanical treatments of poor-quality habitat areas. Wildlife habitat monitoring studies are being conducted to assess the results of management toward meeting wildlife objectives. In cooperation with the USFWS and AGFD, several species have been reintroduced to former ranges, and existing populations have been augmented. These include pronghorn, desert bighorn sheep, mule deer, and Merriam's turkey, as well as northern leopard frog and Apache trout.

The AGFD Wildlife Action Plan provides a strategic framework and information resource designed to help conserve terrestrial and aquatic wildlife and their habitats in Arizona (AGFD 2010b). The action plan focuses on habitat types, provides recommended conservation actions for each habitat type on a regional basis, and develops conservation priorities for the 183 SGCN in Arizona. Included among these SGCN are 28 crustaceans and mollusks, 33 fish, 12 amphibians, 26 reptiles, 49 birds, and 35 mammals. Special attention is given to federally listed species, federal candidate species, species currently petitioned for listing, recently delisted species, and species for which conservation agreements already exist.

Several species listed as SGCN occur in the proposed withdrawal area, and most of these are addressed in Section 3.8 as special status species. Among the SGCN addressed in Section 3.8 include Niobrara ambersnail, Kanab ambersnail, northern leopard frog, relict leopard frog, Sonoran desert tortoise, flannelmouth sucker, humpback chub, razorback sucker, speckled dace, bluehead sucker, olive-sided flycatcher (*Contopus borealis*), sage thrasher, western yellow-billed cuckoo, northern goshawk, American peregrine falcon, western burrowing owl, Mexican spotted owl, southwestern willow flycatcher, condor, bald eagle, Yuma clapper rail, desert bighorn sheep, pronghorn, southwestern river otter, Mogollon vole, Merriam's shrew, Houserock Valley chisel-toothed kangaroo rat, black-footed ferret, greater western mastiff bat, western red bat, western yellow bat (*Lasiurus xanthinus*), and big free-tailed bat (AGFD 2010b).

Several additional SGCN may occur on or are known to occur in the vicinity of the proposed withdrawal area. These include a variety of avian species found at higher elevations in habitats (i.e., mixed conifer, spruce-fir, aspen) on the Kaibab Plateau but not on the parcels themselves. Based on breeding distribution maps in Corman and Wise-Gervais (2005), these bird species include American three-toed woodpecker (*Picoides tridactylus*), western purple martin (*Progne subis*), red-naped sapsucker (*Sphyrapicus nuchalis*), Lewis's woodpecker (*Melanerpes lewis*), Lincoln's sparrow (*Melospiza lincolnii*), MacGillivray's warbler (*Oporornis tolmiei*), downy woodpecker (*Picoides pubescens*), green-tailed towhee (*Pipilo chlorurus*), ruby-crowned kinglet (*Regulus satrapa*), and golden-crowned kinglet (*R. calendula*).

American three-toed woodpecker (*Picoides tridactylus*)

It is unknown whether the American three-toed woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. American three-toed woodpeckers are generally associated with spruce forests, although their occurrence in other types of coniferous forest varies geographically (Short 1974). American three-toed woodpeckers occur as far north as Alaska and extend through the boreal forests of Canada south into the lower 48 states. American three-toed woodpeckers flake off bark to forage on bark beetles (Scolytidae) and are typically found in old growth forests and/or disturbed areas that have high densities of bark beetle larvae (Short 1974). While any disturbance that produces a large number of dead/decaying trees may be important for this species (i.e., insect outbreaks, flooding, disease), multiple studies have noted the importance of burns for American three-toed woodpeckers (Short 1974).

Western purple martin (*Progne subis*)

It is unknown whether the western purple martin is located within the proposed withdrawal area, but it is a species that is possible in the region. The purple martin can be found throughout North America in summer and winters in South America (Animal Diversity Web 2010). The original habitat of this species was probably forest edge and riparian habitats, but many populations now inhabit cities and towns. The habitat of this species is coniferous forests near water sources. The diet of this species is flying insects (Animal Diversity Web 2010).

Red-naped sapsucker (*Sphyrapicus nuchalis*)

It is unknown whether the red-naped sapsucker is located within the proposed withdrawal area, but it is a species that is possible in the region. The red-naped sapsucker is a woodpecker of lower elevations in the Rocky Mountains (NatureServe 2005). It prefers to make sap wells in willow trees but will use a variety of tree species. Their habitat includes mixed forests in the Rocky Mountains and Great Basin areas of North America. They nest in cavities of dead trees.

Lewis's woodpecker (*Melanerpes lewis*)

It is unknown whether the Lewis's woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. This species is associated with mature montane and riparian forests from interior southern Canada to Arizona and New Mexico and from coastal California east to Colorado (Cornell Laboratory Ornithology 2010a).

Three principal habitats are open ponderosa pine forest, open riparian woodland dominated by cottonwood, and logged or burned pine forest; however, breeding birds are also found in oak woodland, nut and fruit orchards, pinyon pine-juniper woodland, a variety of pine and fir forests, and agricultural areas, including farm and ranchland. Important aspects of breeding habitat include an open canopy, a brushy understory offering ground cover and abundant insects, dead or downed woody material, available perches, and abundant insects (Cornell Laboratory of Ornithology 2010a).

Lincoln's sparrow (*Melospiza lincolnii*)

It is unknown whether the Lincoln's sparrow is located within the proposed withdrawal area, but it is a species that is possible in the region. Lincoln's sparrow occurs from northern Canada south through the Rocky Mountains and the Pacific coastal ranges to southern California, Arizona, and New Mexico (Utah Division of Wildlife Resources 2010c). During winter, it is found in the south-central and southwestern United States, south to Honduras. Habitats used by Lincoln's sparrow during the breeding season include wet meadows, bogs, and riparian thickets, especially where these habitats include willows and where shrub cover is dense; during migration and in winter, this species uses a much broader array of habitats, ranging from weedy pastures to tropical forests. This species feeds mainly on terrestrial invertebrates (arthropods) and small seeds.

MacGillivray's warbler (*Oporornis tolmiei*)

It is unknown if the MacGillivray's warbler is located within the proposed withdrawal area, but it is a species that is possible in the region. MacGillivray's warblers are migratory birds that spend their summers in temperate forests located in the western United States and in boreal forests of west Canada (Cornell Laboratory of Ornithology 2010b). In autumn, these birds will migrate back to Central America, where they will stay in temperate shrublands for the winter. This species primarily feeds on insects but will also take spiders and occasionally worms. They also are known to feed at sapsucker drill wells.

Downy woodpecker (*Picoides pubescens*)

It is unknown whether the downy woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. The downy woodpecker is a common year-round resident in forests, riparian woodlands, parks, and suburbs throughout Canada and most of the United States (Utah Division of Wildlife Resources 2010d). The diet of the downy woodpecker consists primarily of insects, but fruits, seeds, and sap are also consumed. Individuals either glean food items directly off of a tree, or drill into tree bark.

Green-tailed towhee (*Pipilo chlorurus*)

It is unknown whether the green-tailed towhee is located within the proposed withdrawal area, but it is a species that is possible in the region. The green-tailed towhee is a large secretive sparrow that uses different habitats throughout its range (Utah Division of Wildlife Resources 2010e). At low elevations, it is found in diverse shrub communities or in pinyon-juniper forests. At higher elevations, it is frequently found in disturbed forests and along forest edges. Green-tailed towhees forage for food under dense cover either on the ground or in low vegetation. They scratch the ground to expose small seeds and insects, which they then pluck off the ground. Less often, they will take insects or fruits directly off vegetation.

Ruby-crowned kinglet (*Regulus satrapa*)

It is unknown whether the ruby-crowned kinglet is located within the proposed withdrawal area, but it is a species that is possible in the region. The ruby-crowned kinglet is a small songbird that breeds in boreal, subalpine, and mixed coniferous forests in Canada and in both the northeastern and western United States (Utah Division of Wildlife Resources 2010f). This bird winters in coniferous and deciduous forests across the United States and into northeastern Mexico. The diet of the ruby-crowned kinglet consists primarily of insects that are either gleaned from leaves and limbs, or chased down and captured.

Golden-crowned kinglet (*R. calendula*)

It is unknown whether the golden-crowned kinglet is located within the proposed withdrawal area, but it is a species that is possible in the region. The golden-crowned kinglet is a small songbird that breeds in boreal, subalpine, and mixed coniferous forests in Canada and in both the northeastern and western United States (Utah Division of Wildlife Resources 2010g). This bird winters in coniferous and deciduous forests across the United States and into northeastern Mexico. The diet of the ruby-crowned kinglet consists primarily of insects that are either gleaned from leaves and limbs or chased down and captured.

3.8.6 Resource Condition Indicators

Table 3.8-6 gives the resource condition indicators for special status species.

Table 3.8-6. Special Status Species Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Special status species habitat	Issues associated with special status species habitat include fragmentation of habitat by roads, noise from exploration or development activities that disrupts species, species disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator*: Acres and type of habitat lost and duration of loss. *Indicator*: Changes in migratory or foraging behavior. *Indicator*: Avoidance or adaptation of species to noise source/visual intrusion. *Indicator*: Acres of habitat loss as a result of establishment of invasive species caused by mineral exploration or development activities.

Table 3.8-6. Special Status Species Condition Indicators (Continued)

	Description of Relevant Issue	Resource Condition Indicator(s)
Special status species populations	Potential loss of critical special status species winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Special status species mortality	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality. In addition to wildlife vehicle accidents, injury to individual plants from crushing or removal and loss or modification of habitat through actions such as clearing and road construction has potential to impacts special status species.	*Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity.

3.9 VISUAL RESOURCES

3.9.1 Introduction

Visual resources are the visible physical features on a landscape and may include land, water, vegetation, animals, structures, and other features. The combination of these physical features creates scenery and provides an overall landscape character. This character is formed by the variety and intensity of the landscape features and the four basic elements of form, line, color, and texture. These factors give an area a unique quality that distinguishes it from its immediate surroundings. Usually, the more variety of these elements a landscape has, the more interesting or scenic the landscape becomes if the elements coexist harmoniously. Scenic quality is the relative value of a landscape from a visual perception point of view.

The region where the proposed withdrawal area is located in Coconino and Mohave counties, Arizona (see Figure 1.1-1), is internationally recognized for its diverse landscapes and scenic qualities and offers many developed and dispersed backcountry recreation opportunities for sightseeing, wildlife viewing, and on-road touring. It attracts large numbers of tourists, varying from local residents to visitors from around the world, who come to the area to enjoy the area's dramatic scenic qualities. Distinct and notable scenic features in the region include the Grand Canyon, Vermilion Cliffs, Kaibab Plateau, Coconino Plateau, Mount (Mt.) Trumbull, and others. The analysis area for visual resources includes lands where potential changes to the landscape may be discerned.

3.9.2 Landscape Character

The proposed withdrawal area is in the southwestern portion of the Colorado Plateau. Scenery throughout the proposed withdrawal area is made up of a diverse variety of physical elements. The landscape is generally characterized by colorful sedimentary rock formations, steep-walled canyons, wooded plateaus, broad plains, dark gray cinder cones, fields of rugged volcanic rock, and major fault scarps. Because of the remote and undeveloped nature of much of the proposed withdrawal area, visitors to the area are rewarded with unrestricted views of forested ridges, steep, colorful canyons, and vast, open plains.

Human modifications occur throughout the proposed withdrawal area and contribute to the overall landscape character. These modifications consist primarily of roads and ranching developments and include some transmission lines, mining development, and trails.

3.9.3 Federal Visual Resource Management Systems

The BLM, Forest Service, and NPS all use a visual resource inventory and contrast analysis process to analyze impacts to visual resources. However, each agency applies its own system to establish Visual Resource Management (VRM) objectives or scenic integrity levels. Typically, a visual resource inventory process involves rating the visual appeal of a tract of land, measuring public concern for scenic quality, and determining whether the tract of land is visible from travel routes or Key Observation Points. This information is used to assign a visual quality rating and management objectives to a tract of land that are subsequently used to manage and analyze activities and uses of that land.

Visual analysis involves determining whether the potential visual impacts from proposed activities or developments would meet the management objectives established for the area. A visual contrast rating process is used for this analysis, which involves comparing the proposed withdrawal features with the major features in the existing landscape using the basic design elements of form, line, color, and texture.

The following sections detail the BLM, Forest Service, and NPS VRM systems.

Bureau of Land Management

The BLM (South and East parcels) uses the VRM system to manage visual resources on public lands (BLM 1986a, 1986b). Most of these two parcels are managed under the direction contained within the Arizona Strip Field Office RMP (BLM 2008b). The primary objective of VRM for the North and East parcels is to maintain the existing visual quality of BLM-administered lands and to protect unique and fragile visual resources. The VRM system uses four classes to describe the different degrees of modification allowed to the basic elements of the landscape (i.e., line, form, color, and texture).
The VRM classes and their objectives are described in Table 3.9-1.

Table 3.9-1. Visual Resource Management Class Descriptions

VRM Class	Description
I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and should not attract attention.
II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
IV	The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements of the landscape.

Forest Service

On most National Forest System lands, the Forest Service uses a Scenery Management System (SMS), which replaces the Forest Service's former Visual Management System (Forest Service 1974) for management of visual resources. *Landscape Aesthetics: A Handbook for Scenery Management*, Agricultural Handbook 701 (Forest Service 1995), defines a system for inventory and analysis of the aesthetic values of National Forest System lands. Both the Forest Service and BLM systems rely on visual inventory and scenic quality classes to manage visual resources.

The Kaibab National Forest currently uses both the SMS and the Visual Management System. The South Parcel is managed under the newer SMS, and the small areas of the Kaibab National Forest within the North and East parcels are managed under the older Visual Management System. The *Environmental Assessment for Amendment of the Kaibab National Forest Management Plan—Recreation and Scenery Management* (Kaibab EA) (Forest Service 2004) determined that the Kaibab National Forest's Visual Management System inventory and mapping was inadequate. This was the result of insufficient visual quality mapping for the Kaibab LRMP/ROD (Forest Service 1988) in which forest managers assigned Visual Quality Objectives (VQOs) to areas of known visual concern (major travel ways, high-use Forest Roads, scenic areas, and recreation sites) but did not map the remaining areas. The Kaibab EA was used to inventory and update VRM on the Kaibab National Forest to the SMS system, but this was only completed for the Tusayan Ranger District (the South Parcel of the proposed withdrawal area). The Kaibab LRMP/ROD was amended to adopt more comprehensive mapping, standards, and the Recreation Opportunity Spectrum (ROS)-SMS Guidebook, but only for the South Parcel. Both Forest Service VRM systems are described below.

VISUAL MANAGEMENT SYSTEM

VQOs are used for VRM of some Forest Service landscapes, depending on the status of the applicable Forest Plan. VQOs establish the acceptable degree of alteration of the characteristic landscape (Table 3.9-2). Each VQO describes a different degree of acceptable alteration of the natural landscape. The degree of alteration is measured in terms of visual contrast with the surrounding landscape generated by introduced changes in form, line, color, or texture. The Kaibab National Forest uses the Visual Management System on their lands within the North and East parcels.

Table 3.9-2. Forest Service Visual Quality Objective Descriptions

VQO Category	Definition
Preservation	Allows ecological change only and management activities that are not noticeable to observers.
Retention	Allows management activities that are not evident to the casual forest visitor.
Partial Retention	Allows management activities that may be evident to the observer but must remain subordinate to the characteristic landscape.
Modification	Allows management activities that may dominate the characteristic landscape but that must, at the same time, use naturally established form, line, color, and texture.

SCENERY MANAGEMENT SYSTEM

The new system used by the Forest Service, the SMS, includes a scenery inventory system similar to the BLM system that assigns Scenic Integrity Objectives (SIOs) to landscapes. The SIO determines the degree of acceptable change or alteration to the visual landscape. The Kaibab National Forest uses the SMS on the Tusayan Ranger District (South Parcel) to guide management activities in terms of visual resources. Table 3.9-3 describes the SIOs.

National Park Service

The proposed withdrawal area does not include lands within Grand Canyon National Park. However, because of the Park's central location and geographic proximity to the three proposed withdrawal parcels the NPS mandate to conserve visual resources is part of the analysis.

Table 3.9-3. Forest Service Scenery Management System Scenic Integrity Objectives

SIO	Landscape Theme
Very High	The landscape is intact, with only minute, if any, deviations. The existing character and sense of place should be expressed at the highest level. Human influence from historic use or management should appear completely natural to the majority of viewers.
High	The landscape appears unaltered and intact. Deviations may be present but should repeat the line, form, color, and textures of the existing landscape character so completely, and at such a scale, that they are not evident.
Moderate	The landscape appears slightly altered. Noticeable changes should remain visually subordinate to the landscape character being viewed.
Low	The landscape appears moderately altered. Deviations and changes to the landscape may begin to dominate the landscape character. These changes should borrow valued landscape attributes such as size, shape, edge effects, patterns of natural openings, vegetative type changes, or architectural styles that are outside the altered landscape.

Source: Forest Service (1995).

NPS does not apply a classification system to managing scenic quality within national parks. As mandated under the Organic Act [16 USC 1], all visual resources and scenic quality within national parks are to be conserved and managed in an unimpaired condition for the enjoyment of future generations. Potential impairment of the resource is determined using context, intensity, duration, and timing to gauge the level of impacts of proposed projects within the National Park System. Through the NEPA process, threshold values have been developed to assist the evaluator in determining whether a project’s activities would constitute an impairment of visual resources. Grand Canyon National Park is managed under a General Management Plan (NPS 1995).

The Organic Act [16 USC 1] also addresses that potential impairment of park resources may result from sources or activities outside the park. The NPS will conduct cooperative conservation to work with others to anticipate, avoid, and resolve potential conflicts and protect park resources.

3.9.4 Visual Resource Descriptions

The following sections describe the existing landscape of each parcel. This is done in terms of the basic elements of the characteristic landforms, vegetation, and human modifications found throughout each parcel. Observation points that are representative of the characteristic landscape within each parcel are identified, and the geographic context of those points is described. Because visual details are diminished the farther the observer is removed, landscapes are subdivided into three distance zones based on relative visibility from travel routes or observation points. The three zones are foreground–middle ground, background, and seldom seen. The foreground–middle ground zone includes views that are less than 3 to 5 miles away. Views beyond the foreground–middle ground zone but less than 15 miles away are usually called background zone. Views not seen as foreground–middle ground or background (i.e., hidden from view) are in the seldom-seen zone. VRM objectives have been assigned by BLM and Forest Service to all lands within the three parcels, and a detailed breakdown of those objectives is provided.

These elements—characteristic landscape, geographic context, and agency VRM objectives—will be the basis for assessing visual impacts through contrast analysis and distance zones in Chapter 4.

North Parcel

The North Parcel is located north of the Grand Canyon and includes portions of the Kanab and the Uinkaret plateaus (Figure 3.9-1). Elevations of the North Parcel vary between 4,000 feet amsl along Kanab Creek to approximately 6,500 feet amsl at Hancock Knoll. As documented in the Arizona Strip ROD/RMP (BLM 2008b), the BLM designated the Kanab Creek, Moonshine Ridge, and Johnson Spring ACECs, the plateau between Nates and Robinson canyons (south of Hack Canyon), and the Old Spanish

National Historic Trail as VRM Class II; an east-west utility corridor as VRM Class IV; and the remainder of the parcel as VRM Class III. Modifications to the characteristic landscape of the North Parcel consist of exploration and development, the utility corridor, and a network of dirt roads to provide access for recreation opportunities, mining operations, livestock grazing, fire suppression, and other land management activities. Table 3.9-4 describes the acres per visual resource classification within the North Parcel, and Figure 3.9-1 depicts the visual resource designations. This parcel also includes a small section of Forest Service land on the east side, along Kanab Creek. This contains the VQO designation of modification on the upper segment of Kanab Creek.

Table 3.9-4. North Parcel Visual Resource Class Acreage for BLM and Forest Service Land

	Acres
BLM VRM Class	
Class I	0
Class II	63,208
Class III	509,935
Class IV	23,422
Forest Service VQO	
Preservation	0
Retention	0
Partial Retention	0
Modification	3,590

For the purposes of this analysis, several observation areas were established within the North Parcel. These observation areas include views along major travel corridors (U.S. 89A, SR 389), Toroweap Road (dirt road), and Big Springs Road (dirt road), as well as several trailheads within and adjacent to the North Parcel (see Figure 3.9-1).

U.S. 89A CORRIDOR

U.S. 89A traverses the eastern portion of the North Parcel from east to west (see Figure 3.9-1). The dominant landscape view is of the vast, open, and undeveloped plains of the gently rolling Kanab Plateau. Views south of U.S. 89A include foreground–middle ground views of Kanab Plateau and possible glimpses of Kanab Creek Canyon, parts of which are within the Kanab Creek Wilderness. Foreground and middle ground views west of U.S. 89A include views of Yellowstone Mesa, while views north of U.S. 89A include views of the Shinarump Cliffs. A primary feature is the vertical rise of the Kaibab Plateau to the west.

SWAPP TRAILHEAD

Swapp Trailhead is located east of Kanab Creek and north of Snake Gulch, with access along BLM Road 22 from U.S. 89A (see Figure 3.9-1). Foreground and middle ground views to the east and south from Swapp Trailhead include the rising Kaibab Plateau and Kaibab National Forest and views across Snake Gulch into the Kanab Plateau to the east. Background views to the west look across Kanab Creek toward Yellowstone Mesa and Antelope Valley.

HACK CANYON TRAILHEAD

Hack Canyon Trailhead is located within the North Parcel, just west of the Kanab Creek Wilderness boundary in Hack Canyon (see Figure 3.9-1). Hack Canyon Trailhead is accessed from SR 389 and Toroweap Road. Foreground and middle ground views to the east of this trailhead include views into Kanab Creek Wilderness and the Kaibab Plateau.

TOROWEAP ROAD CORRIDOR WITHIN ANTELOPE VALLEY

Toroweap Road is one of two major roads within the North Parcel and is accessed from SR 389 west of Fredonia, Arizona (see Figure 3.9-1). In general, Toroweap Road cuts across the North Parcel in a southwesterly direction through the Kanab Plateau and Antelope Valley. Views from Toroweap Road, while within Antelope Valley, include foreground and middle ground views of rolling plains; background views of Findlay Knolls, Heaton Knolls, and Hancock Knoll. Middle ground views west from Toroweap Road include views of Antelope Valley. Middle ground views north from Toroweap Road include views of Yellowstone Mesa and more background views of the Vermilion Cliffs.

CLAYHOLE ROAD CORRIDOR

Clayhole Road/BLM Road 5 is located along the western boundary of the North Parcel, and like Toroweap Road, it provides access for several recreation sites within Grand Canyon National Park (see Figure 3.9-1). Typical views near the road include a flat landscape with distant view of mesas and the Canaan and Cottonwood mountains to the north. The southern portion of the road has distant views of a few small cinder cones. Views east of Clayhole Road include foreground and middle ground views of Yellowstone Mesa and Antelope Valley. Foreground and middle ground views south include Toroweap Valley and background views of distant plains.

SR 389 CORRIDOR

SR 389 is located outside the North Parcel and offers casual travelers background views of various locations within the North Parcel (see Figure 3.9-1). Views are dominated by vast, open, undeveloped plains of the Kanab Plateau, which contain sagebrush and grass vegetation. The dominant visual elements include views south of the Uinkaret Plateau, Yellowstone Mesa, Antelope Valley, and Kanab Plateau. Located approximately 3 miles south of SR 389 is an east-west utility corridor within the North Parcel, which is visible in the foreground and middle ground views from SR 389.

East Parcel

The East Parcel is located south of the Paria Plateau and Vermilion Cliffs National Monument and west of the Colorado River (Figure 3.9-2). The East Parcel varies between 4,400 and 5,600 feet amsl, and vegetation is dominated by grassland species, and sparse juniper trees and shrubs. U.S. 89A is generally the northern boundary of the East Parcel. BLM Road 8910 (Buffalo Ranch Road) and a network of dirt roads provide access to the Rider Canyon and North Canyon trailheads, livestock grazing facilities, and other land management activities. The casual observer has view of the East Parcel from along U.S. 89A. This paved road follows near the base of the Vermilion Cliffs.

Table 3.9-5 lists the number of acres per visual resource classification within the East Parcel. Figure 3.9-2 depicts the visual resource classifications within the East Parcel. The north half of House Rock Valley is designated Class II because of broad vistas from U.S. 89A and the Vermilion Cliffs area. The Marble Canyon ACEC is also designated Class II. The southern portion of the East Parcel is designated VRM Class III. The Paria Canyon–Vermilion Cliffs Wilderness, adjacent to this parcel, is designated Class I. A segment of Forest Service land is included within the western edge of the parcel. This is designated a VQO modification, except for a small partial retention corridor along U.S. 89A.

Table 3.9-5. East Parcel Visual Resource Class Acreage for BLM and Forest Service Land

	Acres
BLM VRM Class	
Class I	0
Class II	63,296
Class III	50,316
Class IV	86
Forest Service VQO	
Preservation	0
Retention	0
Partial Retention	818
Modification	30,494

U.S. 89 CORRIDOR

U.S. 89 is located on the Navajo Nation and east of the East Parcel (see Figure 3.9-2). U.S. 89 provides casual observers foreground and background views of the East Parcel and varies in distance from just a few miles away to more than 20 miles away. Background views include the canyon walls of the Colorado River and views of House Rock Valley.

U.S. 89A–SOAP CREEK TRAILHEAD

Two observation points along U.S. 89A were established within the East Parcel and include House Rock Valley Overlook and Soap Creek Trailhead (see Figure 3.9-2). Soap Creek Trailhead is located east of U.S. 89A, a few miles southwest the Marble Canyon Bridge crossing over the Colorado River. Foreground and background views east include views of Echo Ridge and Marble Canyon. Background views west from this observation point include views of House Rock Valley and U.S. 89A. Foreground views of Vermilion Cliffs are possible north of this observation point.

U.S. 89A–HOUSE ROCK VALLEY OVERLOOK

House Rock Valley Overlook is located along of U.S. 89A on the Kaibab National Forest (see Figure 3.9-2). This is a popular overlook that experiences high visitation from regional travelers. It provides unbroken views of the House Rock Valley area, which is surrounded by the Vermilion Cliffs to the north and Marble Canyon to the east. More distant views include the Kaibab Plateau and Kaibab National Forest.

RIDER CANYON TRAILHEAD

Rider Canyon Trailhead is located within the East Parcel and is accessed by BLM Road 8910 south of SR 389 (see Figure 3.9-2). Views east of this observation point include foreground views of Rider Canyon. Background views toward Echo Cliffs on the Navajo Nation are also possible. Middle ground views south of this observation point include House Rock Valley. West of this observation point are background views of House Rock Valley, Kaibab Plateau, and Kaibab National Forest. North of this observation point are middle ground views of the Vermilion Cliffs.

South Parcel

The South Parcel is located south of the Grand Canyon and is managed by the Forest Service. The South Parcel slopes from northeast to southwest, and elevations vary from approximately 5,800 to 7,000 feet amsl. Vegetation within the eastern portion of the South Parcel is dominated by grasslands interspersed with scattered juniper and shrubs, while vegetation in the western and northern portions of the parcel is predominantly tall ponderosa pine forests. Red Butte is one of the few features of vertical relief on the South Parcel; it rises in the southern portion of the parcel. The Coconino Rim, in the northeastern portion of the parcel, rises up from the Colorado River and also presents a distinct view. Dramatic views of the Grand Canyon occur at various points in the parcel.

The South Parcel is intersected by several paved routes and Forest Service roads. U.S. 180/SR 64 is a north-south transportation corridor in the western portion of the South Parcel. Forest Service Road 302 runs predominantly from east to west in the middle of the South Parcel, and SR 64 is located in the northeastern portion of the South Parcel.

Table 3.9-6 presents acres of SIOs for the South Parcel, as illustrated in Figure 3.9-3. Areas classified as “high” include Red Butte and the Coconino Rim area. Most of the parcel is designated “moderate,” with a few isolated pockets of “low.”

Table 3.9-6. South Parcel Visual Resource Class Acreage

SIO	Acres
Very High	0
High	25,519
Moderate	283,291
Low	15,621

RED BUTTE–SR 64 OBSERVATION POINT

The Forest Service has established one official visual quality observation point within the South Parcel. Red Butte SIO-2 encompasses a 3,545-acre area and is located east of SR 64 in the southwestern portion of the South Parcel (see Figure 3.9-3). Red Butte is accessed by Forest Service Road 305. The casual traveler within the South Parcel would have viewing opportunities along SR 64 and from several existing Forest Service dirt roads. Views of the casual observer traveling along SR 64 in the southwestern portion of the South Parcel would include foreground and middle ground views of rolling terrain with grassland and junipers, with the highest feature (Red Butte) visible. The top of Red Butte is accessible by a hiking trail and provides hikers with broad regional views that include the San Francisco Peaks and north to the Grand Canyon and Mt. Trumbull.

TUSAYAN–STATE ROUTE 64 CORRIDOR

Views along SR 64 in the northwestern portion of the South Parcel would be mostly limited to the foreground views and existing right-of-way because of the abundance of ponderosa pine trees. SR 64 and the Grand Canyon Railroad are major transportation features in the western portion of the South Parcel (see Figure 3.9-3). The Grand Canyon Airport, an established Forest Service campground (Ten-X), and the town of Tusayan are also located in the northwestern portion of the South Parcel.

EASTERN STATE ROUTE 64 CORRIDOR

The casual observer traveling along SR 64 in the eastern portion of the South Parcel would have foreground views of rolling terrain with sparse vegetation (see Figure 3.9-3). The casual observer would also have background views west of the northeastern slopes of the Coconino Rim and background views east toward the Little Colorado River. The casual observer travelling within Grand Canyon National Park has some views into the South Parcel from the SR 64 corridor. These include background views of Red Butte and minimal foreground views.

FOREST SERVICE ROAD 302 CORRIDOR

The South Parcel also contains a network of dirt roads that serve recreation, grazing, and fire maintenance activities. Forest Service Road 302 is an east-west road that is approximately in the middle of the South Parcel and has a network of dirt roads branching from it (see Figure 3.9-3). Views from select locations along these dirt roads would vary but in general are limited to foreground views because of the natural topography of rolling hills, ridges, and drainages. One east-west utility line (power) easement is located in the southern portion of the South Parcel.

Grand Canyon National Park

There are several viewpoints and visual corridors within Grand Canyon National Park that are in the vicinity of the proposed withdrawal area or provide potential views into the withdrawal area. These areas are described below and illustrated in Figure 3.9-3.

KANAB POINT

Kanab Point is part of Grand Canyon National Park and is accessed through the North Parcel from SR 389 and Toroweap Road (see Figure 3.9-1). Foreground and middle ground views to the east and south of this point include views of the Colorado River Canyon and Kanab Creek Wilderness. Foreground and middle ground views to the north include the Kanab Creek Wilderness.

TUCKUP CANYON TRAILHEAD

Tuckup Canyon Trailhead is located within Grand Canyon National Park and accessed from SR 389 via Toroweap Road (see Figure 3.9-1). Foreground and middle ground views to the east and south of this trailhead include views of the canyons of the Colorado River and tributaries. West of Tuckup Canyon Trailhead are background views of Mount Logan and Mount Trumbull. North of the Tuckup Canyon Trailhead are foreground and middle ground views toward Hancock Knoll.

BRIGHT ANGEL POINT

Bright Angel Point is a paved pedestrian overlook on the North Rim near the North Rim Lodge and is accessed via SR 67. Bright Angel Point overlooks the Grand Canyon with a vista that extends from the southeast to the southwest. Foreground views extend from Angel’s Gate and Coronado Butte to the southeast and continue west to the area of Osa Butte and Powell Memorial. The point overlooks the Bright Angel Fault, and Grand Canyon Village is visible across the canyon. Because of the higher elevation of the North Rim relative to the South Rim, background views extend far to the include the San Francisco Peaks, Red Butte, SR 64 to Grand Canyon Village and Bill Williams Mountain.

POINT IMPERIAL

Point Imperial, located on the North Rim in Grand Canyon National Park, is accessed by the Point Imperial Road. It is the highest point on the North Rim, at 8,803 amsl. It overlooks the Painted Desert and the east end of Grand Canyon.

CAPE ROYAL

Cape Royal is a panoramic viewpoint located within Grand Canyon National Park on the North Rim. Cape Royal is accessed via SR 67 and the Cape Royal Road. Cape Royal’s high vantage point provides extensive foreground views of the Grand Canyon region extending from the northeast to the northwest. Foreground views include Wotan’s Throne and the Palisades of the Desert, Vishnu Temple, Coronado Butte, and Bright Angel Canyon in Grand Canyon. Background views include the Little Colorado River Valley, Desert View, the San Francisco Peaks, Red Butte and Point Sublime. To the North is the Walhalla Plateau in Grand Canyon National Park.

CAPE FINAL

Cape Final is accessed via a short trail hike from Cape Royal Road. Cape Final offers foreground views to the north into Marble Canyon in Grand Canyon and the Marble Platform. Background views include the Vermilion Cliffs, Echo Cliffs, and Navajo Mountain. It provides views to the east of Cape Solitude and the Little Colorado River valley. Views to the south include foreground views of Grand Canyon, middle ground views of Desert View, and background views of Mount Humphreys. Cape Royal and the Walhalla Plateau in Grand Canyon are visible west of Cape Final.

SOWATS POINT

Sowats Point is located on Forest Service land overlooking Jumpup and Kanab canyons. Middle ground views to the west include the Kanab Plateau and Jumpup Point. Background views to the west include Mt. Trumbull and Mt. Logan. Views to the south include Fishtail Mesa in Grand Canyon National Park. Views to the north extend into upper Jumpup Canyon.

HOPI POINT

Hopi Point is located in the south rim area of Grand Canyon National Park west of Grand Canyon Village along the Hermits Rest Road. It provides views of the Grand Canyon and the North Rim, along with some views of the Colorado River to the west.

TRAILVIEW OVERLOOK

Trailview Overlook is accessed by Hermit Road This viewpoint provides views of the Bright Angel Trail, Bright Angel Creek, and Plateau Point. Background views to the south include the Kaibab Plateau, Red Butte, the San Francisco Peaks, and Bill Williams Mountain.

GRANDVIEW POINT

Grandview Point is located in the South Rim area of Grand Canyon National Park along Desert View Drive. This popular viewpoint offers panoramic views of Grand Canyon from east to west, including several bends of the Colorado River to the east.

DESERT VIEW WATCHTOWER

Desert View Watchtower is located at the east end South Rim area of Grand Canyon National Park along Desert View Drive. The viewing tower, at 70 feet high, is the highest point on the South Rim. The tower provides panoramic views of the region, including the Grand Canyon, the Painted Desert to the east, and the San Francisco Peaks to the south. Foreground views of Grand Canyon extend from north to west. To the east, foreground views include Cedar Mesa and the Navajo Reservation. Background views to the north and east extend to the Marble Platform, Navajo Mountain, Echo Cliffs, and Little Colorado River Canyon.

HERMIT ROAD CORRIDOR

Hermit Road is a scenic route along the west end of Grand Canyon Village on the South Rim that follows the rim for 7 miles out to Hermits Rest. This road is accessed by park shuttle bus, foot, and bicycle most of the year, with private vehicles allowed only during winter months. The road provides access to several viewpoints and offers views of the Grand Canyon to the north and the Kaibab Plateau to the south.

HAVASUPAI POINT

Havasupai Point is located on the South Rim of Grand Canyon National Park approximately 30 miles from Grand Canyon Village and is primarily accessed by Forest Road 328 and Havasupai Point Road in Grand Canyon National Park. Havasupai Point offers views of Grand Canyon from east to west. Point Sublime and Powell Plateau on the North Rim are both visible from Havasupai Point.

3.9.5 Night Sky

The nighttime visual resources (e.g., “dark night skies”) of northern Arizona and southern Utah are nationally significant and represent one of the best opportunities for the American public to experience such a sight (BLM 2008b). These dark night skies are an important characteristic of the remote setting and contribute to the nighttime visual landscape of the area. All parcels in the proposed withdrawal area provide outstanding opportunities for visitors to experience significant views of stars and other objects in the night sky.

Light pollution is caused by outdoor lights that are upwards or sideways. Any light that escapes upward, unless blocked by an object, will scatter throughout the atmosphere and brighten the night sky. Air pollution particles also increase the scattering of light at night, just as they impact visibility during the daytime.

The NPS has developed a system for measuring sky brightness to quantify the source and severity of light pollution and is monitoring parks in the region of the proposed withdrawal area. The nearest monitoring site is in Grand Canyon–Parashant National Monument, which is directly east of the North Parcel. The most recent data were collected at McDonald Flat on February 24, 2006, as detailed in the night sky quality monitoring report (NPS 2006a). The report states

> Seeing good, transparency very good, daytime visibility about 80 miles. Very dark at zenith, very little airglow tonight. Detail in Milky Way extensive, galactic light extends east to Beehive cluster in Cancer and nearly to Polaris in Ursa Minor. Gegenschein easy, zodiacal band visible from Saturn through gegenschein east into the airglow. Light dome of Las Vegas casts a shadow, irritates night vision, definitely brightest thing in the sky. Noticeable decrease in size and brightness as night progresses. Other light domes minimal intrusion on an otherwise pristine sky. (NPS 2006a)

The report also discusses zenith limiting magnitude, which refers to the faintest stars that can be observed with the naked eye. There are 14,000 stars visible at magnitude 7.0 conditions, 5,000 stars visible at magnitude 6.0 conditions, and only a few dozen stars visible at magnitude 1.0. The best night skies range from magnitude 6.6 to 7.5. The Grand Canyon–Parashant National Monument had a zenith limiting magnitude value of 7.1, which is at the high end of the scale and provides views of approximately 14,000 stars.

3.9.6 Grand Canyon National Park Class I Airshed

Grand Canyon National Park is classified under the CAA as a Class I area. This requires the PSD of air quality and allows only very small increments of new pollution above already existing air pollution levels. An important visual resource component of air quality in Grand Canyon National Park is "visibility." Scenic vistas can be diminished by haze that reduces contrast, color, and visibility of landscape features. A change in contrast of not more than 5% at sensitive view areas is considered acceptable.

The Cooperative Institute for Research in the Atmosphere operates a network of visibility monitoring stations in or near Class I areas and publishes IMPROVE data. The purpose of this monitoring is to identify and evaluate patterns and trends in regional visibility. Data from three IMPROVE monitors within Grand Canyon National Park show that fine ($PM_{2.5}$) and coarse (PM_{10}) particulates were the largest contributors to the impairment of visibility. These particulates impact the standard visual range for each monitor location. The standard visual range is the distance that can be seen in a given day. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park (GRCA1, GRCA2, and INGA1) range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days (IMPROVE 2010).

For a more detailed discussion on Air Quality, see Section 3.2.

3.9.7 Visual Quality Indicators

The specific indicators for visual resource conditions are as follows:

- Consistency with and conformity to designated BLM VRM class objectives;
- Consistency with and conformity to Forest Service scenic quality management or integrity objectives;
- Consistency with and conformance to Park visual objectives from key viewpoints within the Park; and
- Qualitative analysis of the potential changes to the darkness of the night sky in the proposed withdrawal parcels and Grand Canyon National Park.

3.10 SOUNDSCAPES

The Grand Canyon National Park Enlargement Act of 1975 [PL 93-620] established that natural quiet should be protected as a resource and a value to the Park. Natural quiet is defined as the level of all natural sounds in an area, excluding all mechanical, electrical, and other human-caused sounds. Natural quiet is the baseline sound level used for this study.

The information presented in this section was derived from the following reports: *Mining Adjacent to Grand Canyon National Park: Potential Impacts to the Natural Soundscape of the Park*, dated January 28, 2010 (Ambrose 2010a), *Sound Levels of Equipment and Operations at the Arizona 1 Uranium Mine in Northern Arizona*, dated June 21, 2010 (Ambrose 2010b), and *Sound Levels and Audibility of Common Sounds in Frontcountry and Transitional Areas in Grand Canyon National Park, 2007–2008* (Ambrose 2008).

3.10.1 Noise Fundamentals

Airborne sound is the rapid fluctuation of air pressure caused by mechanical vibrations. Noise is defined as unwanted sound that interferes with normal activities or in some way reduces the quality of the environment. Response to noise varies according to its type, perceived importance, appropriateness in the setting, time of day, and the sensitivity of the individual receptor.

Definitions of Acoustical Terms

The following section describes the acoustical terms used throughout this analysis.

- *Ambient noise level* is defined as the composite of noise from all sources near and far, the normal or existing level of environmental noise at a given location.
- *Decibel* (dB) is the physical unit commonly used to describe sound levels. Technically, a dB is a unit of measure that describes the amplitude of sound equal to 20 times the base 10 logarithm of the ratio of the reference pressure to the sound of pressure, which is 20 micropascals (µPa).

Sound measurement is further refined by using a *decibel "A-weighted" sound level* (dBA) scale that more closely describes how a person perceives sound. The dBA scale is logarithmic; therefore, individual dBA values for different sources cannot simply be added together to calculate the sound level for the two sources. For example, two 50-dBA sources, added logarithmically, produce a collective noise level of 53 dBA.

- *Equivalent noise level* (L_{eq}) is the energy average A-weighted noise level during the measurement period.
- *Intruding noise* is the noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends on its amplitude, duration, frequency, time of occurrence, and tonal informational content, as well as the prevailing ambient noise level.
- *Percentile noise level* (L_n) is the A-weighted noise level exceeded during n% of the measurement period. For example, L_{10} is a relatively loud noise exceeded only 10% of the time, while L_{90} is a relatively quiet sound exceeded 90% of the time. People tend to exhibit differing sensitivity to noise depending on the time of day, with noise generated at night being more annoying than that generated during the day.

Sound Levels of Representative Sounds and Noises

A *day-night average noise level* (L_{dn}) is used to determine whether noise would be perceived adversely. The EPA developed an index (threshold) to assess noise impacts from a variety of sources using residential receptors. If L_{dn} values exceed 65 dBA, residential development is not recommended (EPA 1974). Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Noise levels during the day in a noisy urban area are frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable and then painful; levels higher than 80 dBA over continuous periods can result in hearing loss. Constant noises tend to be less noticeable than irregular or periodic noises. Table 3.10-1 presents sound levels for some common noise sources and the human response to those decibel levels.

Table 3.10-1. Sound Levels of Representative Sounds and Noises

Source	Sound Level (dBA)	Human Response
Jet Takeoff (Nearby)	150	
Jet Takeoff (50 feet)	140	
50-HP Siren (100 feet)	130	
Loud Rock Concert (Near Stage)	120	Pain threshold
Construction Noise (10 feet)	110	Intolerable
Jet Takeoff (2,000 feet)	100	
Heavy Truck (25 feet)	90	
Garbage Disposal (2 feet)	80	Constant exposure endangers hearing
Busy Traffic	70	
Normal Conversation	60	
Light Traffic (100 feet)	50	Quiet
Library	40	
Soft Whisper (15 feet)	30	Very quiet
Rustling Leaves	20	
Normal Breathing	10	Barely audible
Threshold of Hearing	0	

Source: Beranek (1988).

3.10.2 Noise Assessment Components

Soundscapes are affected by the following factors:

- Proximity to noise sensitive areas (NSAs): NSAs are defined as the occupants of a location where a state of quietness is a basis for use or where excessive noise interferes with the normal use of the location. Typical NSAs include parks and wilderness areas. Natural soundscapes are an accumulation of all natural sounds that occur in the unpopulated parks and wilderness areas. The NSAs of concern in or near the proposed withdrawal area include the following: Kaibab National Forest, the Vermilion Cliffs National Monument, the North Rim of the Park, Bright Angel Point, the east entrance to the Park (Desert View), the South Rim of the Park, and Yavapai Point Museum. The critical question is whether the NSAs will be adversely affected by proposed withdrawal noise.
- "Transmission path" or medium: The "transmission path" or medium for sound or noise is most often the atmosphere (i.e., air), while for vibration, the medium is the earth or a human-made structure. In order for the noise/vibration to be transmitted, the transmission path must support the free propagation of the small vibratory motions that make up the sound and vibration energy. Atmospheric conditions (e.g., wind speed and direction, temperature, humidity, precipitation) influence the attenuation of sound. Barriers and/or discontinuities that attenuate the flow of sound or vibration energy may compromise the path.
- Source: The sources of sound and vibration are any generators of small back-and-forth motions (i.e., motions that transfer their motional energy to the transmission path where it is propagated). The acoustic characteristics of the sources are very important. Sources must generate sound or vibration of sufficient strength, approximate pitch, and duration so that the sound or vibration

may be perceived and is capable of causing adverse effects, compared with the natural ambient sounds. The new sources of proposed withdrawal noise/vibration are discussed further in Chapter 4.

3.10.3 Regulatory Setting

The following subsections identify federal, state, and local laws and regulations that are pertinent to the evaluation of the proposed withdrawal area and analysis of soundscape impacts.

Federal laws and regulations: There are numerous laws and guidelines at the federal level that are relevant to the assessment of air and ground transportation noise and vibration impacts. These include the following:

- Federal Highway Administration Procedures for Abatement of Highway Traffic Noise and Construction Noise [23 CFR 772]
- National Environmental Policy Act of 1969 [PL 91-190, 42 USC 4321, *et seq.*, 40 CFR 1506.5]
- Noise Control Act of 1972, as amended [PL 92-574, 42 USC 4901 *et seq.*]
- Occupational Safety and Health Administration (OSHA) Occupational Noise Exposure; Hearing Conservation Amendment (*Federal Register* 48[46]:9738–9785)
- Mine Safety and Health Administration (MSHA) Occupational Noise Exposure [30 CFR 62]
- U.S. Surface Transportation Board Environmental Rules [49 CFR 1105.7(6)]
- Special Flight Rules in the Vicinity of Grand Canyon National Park [14 CFR Part 91 et al.]
- National Park Service Director's Order 47: Soundscape Preservation and Noise Management, December 1, 2004.
- The Coconino County Comprehensive Plan, September 23, 2003.

In addition to the aforementioned regulations, NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

There are no BLM, Forest Service, or state noise regulations or standards applicable to exploration or development activity or to the proposed withdrawal area.

3.10.4 Existing Conditions

All three of the proposed withdrawal parcels border Grand Canyon National Park. The area is naturally quiet and generally not subject to modern sources of unnatural sound intrusion or noise. Natural ambient sound levels in non-tourist areas of the Park are generally low level, ranging from 18.3 to 22.8 dBA, with a log mean natural ambient sound level of 20.8 dBA. The existing ambient (L50) sound levels in tourist areas vary, depending on the amount of visitation, but are consistently higher than the L50 levels in the same acoustic zones of non-tourist areas. The L50 of the busiest, most visited front country areas are 20 to 30 dBA higher than the L50 in non-tourist areas of the same acoustic zone. At tourist areas with fewer visitors or with restrictions on vehicle access, the differences are much smaller (Ambrose 2010a).

The existing ambient L50 levels in tourist areas of the Park during the daytime, in the summer, range from 23.7 dBA (measured 3.7 miles below the Grand Canyon rim along Bright Angel Trail) to 56.6 dBA at the west end of Village Loop Road (Ambrose 2008). Current potential sound sources include highway traffic, tour and commercial airplane over flights, vehicles, and Park visitors (Ambrose 2010b).

The current soundscapes of the Kaibab National Forest consist of both natural sounds and a variety of human-generated sounds. The major noise producers include highway traffic, military overflights, and general aviation flights (BLM 2007).

The current soundscape of the Havasupai, Hopi, Hualapai, Kaibab-Paiute, and Navajo reservations consists of both natural ambient sounds and a variety of human-generated sounds. Noise sources include some residential noise, air tour flights, commercial flight patterns, highway traffic, and visitors to the monuments and reservations.

In August 2009, Denison received authorization from the ADEQ to operate its Arizona 1 Mine, located approximately 35 miles south of Fredonia, Arizona. This mine is in the North Parcel of the proposed withdrawal area. The mine started operations in December 2009. Denison Mines provided a list of equipment to be used at the Arizona 1 Mine site that could be considered typical of equipment that would likely be used at other mines in the areas, operating under similar mining conditions (personal communication, Lorraine Christian, BLM 2010). The equipment in use at the Arizona 1 Mine includes the following:

- 40-ton haul trucks (loaded with 25 tons of ore)
- Two front-end loaders with 2.5- to 3.5-yard buckets
- One water truck
- One forklift
- One vent fan
- One sorting screen
- One emergency generator
- Electric transformer

The above equipment list was included for illustration purposes only. Any proposed future mine site locations would be expected to use differing numbers and varieties of mining equipment, and any attempt to extrapolate sound levels from data relating to this existing mining operation is impractical and therefore unwarranted.

General Description of Resource

Noise related to uranium mining activities results from initial heavy-duty construction equipment operations (e.g., trucks, backhoes, excavators, etc.) and long-term from production operations (e.g., haul trucks, mine shaft vent fans, sorting screen operations, etc.). The region of influence attributed to any noise source is based on the location of noise-sensitive receptors relative to the activity. To properly evaluate any potential effects that could be caused by noise, each individual sound-producing activity would need to be evaluated/modeled using the specific mine site location, number and types of equipment, operation schedules, site-specific topography, and climatic conditions relative to the projected location of receptors of concern.

Resource Condition Indicators

The soundscape condition indicators to be evaluated in Chapter 4 of this assessment are as follows:

- Discussion of the possible changes in ambient noise levels in the immediate vicinity of any proposed uranium mine sites. The nature of noise modeling requires specific details regarding the locations and distances between all sources and receivers of interest.

- Discussion of the potential increases in ambient noise levels in the immediate vicinity of any proposed uranium mine site operational activities, compared with the existing baseline noise levels at the nearest NSA.
- Discussion of the potential increases in ambient noise levels associated with mine exploration and development activity to determine compliance with applicable federal regulations and federal land manager rules, policies, and orders.

To assess the current value of the resource condition indicators, measurement of existing background noise levels in the specific area of any potential mine sites would be required. Once the background values have been accurately established, screening level noise models could be run. Either measured or manufacturer noise data from proposed mining equipment would be used for modeling. The results of the model would allow for a mathematically sound estimate of possible noise effects of proposed mining operations at virtually any remote receiver of interest as agreed to by the concerned parties. Without specific knowledge of the location of potential mine sites, no realistic conclusions can be drawn with regard to the possible noise effects of their operation on the Park or any other nearby receiver of concern.

Federal law establishes special rules for the air space in and around Grand Canyon National Park. As a minimum condition, any potential helicopter prospecting operations would need to be conducted within those established guidelines. Cursory noise estimates of these operations cannot be reliably completed without knowing specific noise characteristics of the helicopter to be used and detailed flight paths for the prospecting operations.

As a first level evaluation, the noise level values produced by the noise model could be compared directly to related noise standards. The EPA has determined that an L_{dn} of 55 dBA protects the public from indoor and outdoor activity noise interference. NPS, under 36 CFR 2.12, Audio Disturbances, prohibits operation of motorized equipment or machinery that exceeds a noise level of 60 dBA at 50 feet, or, if below that level, nevertheless makes noise that is unreasonable.

Current Value Resource Condition Indicators

The current value or condition of the soundscape within the proposed withdrawal parcels with respect to each of the resource condition indicators is presented in Table 3.10-2.

Table 3.10-2. Soundscape Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Noise disruption from exploration or development activity	The areas subject to noise effects and the intensity of sound from these activities need to be evaluated for each proposed site and all associated operations. Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park.	*Indicator*: The decibel level due to exploration and mining equipment. *Indicator*: The distance and direction between the source and receiver and for the evaluation of noise attenuation to baseline sound levels. *Indicator*: Comparison measured or modeled values with applicable rules, policies, or orders established by the federal land managers. *Indicator*: Comparison of specified values to regulations established by the EPA and the U.S. Department of Transportation.

3.11 CULTURAL RESOURCES

Cultural resources are physical phenomena associated with past or present cultures and include archaeological sites and historic buildings and structures, as well as places of traditional religious and cultural importance. Cultural resources also include TCPs, which is a formal designation for properties vital to a community's practices and beliefs. These properties are tied to a community's cultural identity. Traditional cultural and sacred places, ethnographic landscapes, and TCPs are addressed in Section 3.12.

Cultural resources refer to both human-made and natural physical features associated with human activity and, in most cases, are finite, unique, fragile, and nonrenewable. The proposed withdrawal area is composed of three parcels, each of which contains unique and distinctive resources that represent several themes that are important to history and prehistory.

Management of resources on all three proposed withdrawal parcels is primarily guided by the NHPA requirements described in Chapter 1. In addition, the BLM and Forest Service have their own supplemental directives and management plans.

3.11.1 Cultural Setting

Archaeologists generally divide the cultural history of the American Southwest into five major periods, whose time spans vary by geographic region. In the Grand Canyon region, these periods include the Paleoindian (9500–6500 B.C.), Archaic (6500 B.C.–A.D. 500), Formative (A.D. 500–1300), Protohistoric (A.D. 1300–1540), and Historic (A.D. 1540–present) (Willey and Phillips 1958). Each of these periods does not represent a single cultural tradition; rather, it signifies the occurrence of several cultures with similar traits that existed at roughly the same time. Even the most "homogeneous" of cultural periods, the mobile hunter-gatherer Paleoindians, can be divided into different traditions based on what type of projectile point was used. The hunter-gatherers of the Archaic produced even more types of projectile points and the first grinding stones for plant processing. The greatest diversity of the prehistoric age can be seen during the Formative, when people practiced agriculture, lived in a variety of structure types, and made and traded many different types of ceramics and other goods. Throughout prehistory, all groups took advantage of the varied resources available in different altitudes and geographic zones. For example, during the Formative and Protohistoric, many people farmed in canyons where the creeks and rivers ran and then would hunt wild game and gather wild plants on the plateaus. With the arrival of the Europeans, the region saw even more varied uses like cattle grazing, mining, timbering, homesteading, railroads, and eventually tourism. Many of these uses by several groups, including American Indians, continue today. See Appendix I for a detailed culture history of the area.

3.11.2 Identification of Prehistoric and Historic Cultural Resources

A Class I inventory of all known cultural resources within the three proposed withdrawal parcels was conducted to quantify site type and distribution (Seymour et al. 2010). The Class I inventory consists of a comprehensive review of files from the BLM, the Kaibab National Forest, and AZSITE (a statewide archaeology database), as well as a review of available literature and maps of the proposed withdrawal area. Sensitivity maps were derived from this information and from analysis of previously published ethnographic information.

Under the NHPA, significant cultural resources are those eligible for the NRHP. To be NRHP eligible, a property must be at least 50 years old (with rare exceptions) and possess integrity of location, design, setting, materials, workmanship, feeling, and association. A site, building, structure, or district may be determined eligible if it meets at least one of four criteria [36 CFR 60.4]:

> Criterion A: Associated with events that have made a significant contribution to the broad patterns of our history;
>
> Criterion B: Associated with the lives of persons significant in our past;
>
> Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> Criterion D: Have yielded, or may be likely to yield, information important in prehistory or history.

Table 3.11-1 provides information on the number of sites and their NRHP eligibility status. Table 3.11-2 enumerates the listed NRHP properties and the criteria under which they were determined eligible.

Within the three parcels, 447 sites have been evaluated and recommended or determined NRHP eligible (see Table 3.11-1). Twelve sites have already been listed in the NRHP (see Table 3.11-2). To date, 196 sites have been recommended or determined ineligible for the NRHP; 1,880 sites have not yet been evaluated with respect to NRHP eligibility status.

Table 3.11-1. National Register of Historic Places Status of Archaeological Sites and Historic-Age Properties by Parcel

	North	East	South	Total
Listed	0	1	11	**12**
Eligible	119	60	268	**447**
Ineligible	97	7	92	**196**
Unevaluated	407	103	1,370	**1,880**
Total	**623**	**171**	**1741**	**2,535**

Table 3.11-2. National Register of Historic Places Listed Properties

Name of Property	Site Number	NRHP Criterion/Criteria
Kane Ranch Headquarters		A
Tusayan Saginaw and Manistee Railroad		A and D
Grand Canyon Railway		A and C
Hull Cabin Historic District		A, B, and C
Grand Canyon Airport Historic District		A and C
Cabin 1	03070400159	A and C
Cabin 6	03070400807	A and C
Tusayan/Moqui Ranger Station	03070400813	A and C
Grand View Lookout Tower and Cabin	03070400621	A and C
Grandview Lookout Tree	03070400860	A
Hull Tank Lookout Tree	03070400868	A
Tusayan Lookout Tree	03070400869	A

Note: With the exception of Kane Ranch Headquarters, which is in the East Parcel, all are located in the South Parcel.

Site density per surveyed acre varies by parcel: the North Parcel has a site density of 13.7 sites per surveyed square mile; the East Parcel has a site density of 32.3 sites per surveyed square mile; and the South Parcel has a site density of 14.8 sites per surveyed square mile. Only 2.5% of the East Parcel has been systematically surveyed; 5.3% of the North Parcel has been systematically surveyed. The South Parcel has the highest number of known sites with the highest percentage of inventoried land. A little more than 23% (23.5%) of the parcel has been subject to systematic inventory. Assuming that the inventory locations were random, at least with respect to the presence or absence of cultural resources, it would be relatively safe to predict a doubling of archaeological sites in the South Parcel. Perhaps as few as 10% of the expected sites have been identified in the North and East parcels. It is likely that the numbers are even higher, since portions of the North Parcel have considerably more available water than the South Parcel. In addition, many sites in the North Parcel were recorded during unsystematic survey. Figures 3.11-1 through 3.11-3 show the concentration of known sites in each parcel by Section. Site concentrations are shown rather than sites per surveyed acre to include those sites recorded during unsystematic surveys.

Site Affiliations and Descriptions

The three parcels contain archaeological sites resulting from thousands of years of human occupation. Table 3.11-3 summarizes the major time periods and cultural affiliations assigned to documented sites. As Paleoindian sites are notably rare, the pre-Formative category combines sites of the Paleoindian and Archaic periods. The Formative category is broadened to include sites of the Protohistoric period, which can be difficult to identify on the basis of site data.

Table 3.11-3. Cultural Affiliation Totals for Each Parcel

		North Parcel	East Parcel	South Parcel	Total
Unknown	Unknown American Indian*	262	34	562	**858**
Pre-Formative	Archaic	45	4	68	**117**
	Paleoindian	1	1	0	**2**
	Paleoindian/Archaic	2	0	0	**2**
Pre-Formative Subtotal		*48*	*5*	*68*	***121***
Formative	Ancestral Puebloan	161	96	305	**562**
	Ancestral Puebloan/Virgin	53	1	0	**54**
	Archaic/Ancestral Puebloan	7	1	0	**8**
	Cerbat and Cerbat/Pai	0	0	32	**32**
	Cohonina	0	0	491	**491**
	Paiute	5	0	0	**5**
Formative Subtotal		*226*	*98*	*828*	***1,152***
Historic	Euro-American	39	9	98	**146**
	Government	1	0	0	**1**
	Havasupai	0	0	1	**1**
	Navajo	0	0	97	**97**
Historic Subtotal		*40*	*9*	*196*	***245***
Unspecified or Limited Information		47	25	87	**159**
Total		**623**	**171**	**1,741**	**2,535**

* The Unknown American Indian category consists of flaked stone artifact scatters with no temporally or culturally diagnostic projectile points or other flaked tools.

The pre-Formative category consists of the following Cultural Affiliation subcategories: Archaic, Paleoindian, and a combination of the two. Unknown American Indian sites are sites that lack distinctive artifacts to support assignment to a specific time period or cultural affiliation. Some of these sites may represent hunting or resource collection sites for later Formative peoples, but they lack ceramics and only contain stone artifacts that cannot be attributed to a certain culture or period. If a site was recorded as having multiple occupational periods or was associated with multiple cultural identities, it was labeled as such. This process of combining multiple information sets applies to all subcategories.

The Formative category consists of numerous cultural identities within the subcategory of Cultural Affiliation: Ancestral Puebloan, Cohonina, etc. The Cultural Affiliation subcategory of the Historic period category consists of various cultural identities, including historic Navajo, Euro-American, and American Indian sites of unknown tribal affiliation. Other categories under Cultural Affiliation for the category of the Historic period are sites that had limited information or sites that could not be determined to be historic or prehistoric in origin; these sites were classified as Indeterminate.

Types of Prehistoric and Historic Sites

The Class I inventory indicates a strong potential for significant prehistoric and historic cultural resources within the three proposed withdrawal parcels in areas that have yet to be inventoried. Because Class III (on-the-ground, intensive) surveys are required prior to authorizing specific surface-disturbing activity, the number of known significant sites is likely to increase over time.

All three parcels contain a diverse range of site types, representing activities and land uses that took place over thousands of years. Approximately one-third of the sites cannot be reliably assigned to a specific cultural tradition or time period. They consist largely of prehistoric or American Indian artifact scatters that lack pottery or other datable items. These sites resulted from temporary use of dispersed locations for traveling, short-term shelter, and collecting natural resources for food, medicine, and production of tools and other items. Although many of these sites may be pre-Formative, others may date to the Formative or later periods, as known Paleoindian and Archaic period sites account for less than 10% of the sites in each parcel.

NORTH PARCEL

As shown in Table 3.11-3, 35% of the known archaeological sites are Ancestral Puebloan sites of the Formative period. Those clearly associated with the Virgin and Virgin/Moapa traditions, centered to the west of the North Parcel, account for 23% of the Formative sites and are rarely found in the East and South parcels. Site types include settlements or habitations, temporary camps, granaries and caches used for food storage, and rock art.

Fewer than 10% of the recorded sites date to the Historic period and reflect the legacy of ranching, homesteading, and mining activities. These sites include cabins, corrals, roads, trails, mines, cairns, and artifact scatters.

EAST PARCEL

As shown in Table 3.11-3, 57% of the known archaeological sites are Ancestral Puebloan sites of the Formative period. The range of site types is similar to that of the North Parcel, except for a cluster of water-control features related to farming activities at the base of the Kaibab Plateau.

About 5% of the sites date to the Historic period and are related primarily to ranching and transportation. Inscriptions are located along the routes of the historic Dominguez-Escalante and Mormon Honeymoon trails, which traversed the northern margin of the parcel below the Vermilion Cliffs.

SOUTH PARCEL

As shown in Table 3.11-3, 46% of the known archaeological sites are Ancestral Puebloan sites, primarily associated with the Cohonina tradition of the Formative period. The Cerbat tradition accounts for 4% of the Formative sites. Site types include settlements or habitations, temporary residences, artifact scatters, and resource procurement and processing locations.

Six percent of the sites are from the Historic period and are associated with ranching, mining, logging, and forest management activities. They include cabins, corrals, mines, roads, five lookout towers, and four railroad tracks/beds. The Civilian Conservation Corps constructed many of the roads, towers, and other facilities in the 1930s. There are also 97 recorded sites attributed to use by the Navajo and one site attributed to the Havasupai, including the remains of temporary shelters, hogans, and sweat lodges.

3.11.3 Resource Condition Indicators

Appropriate resource condition indicators for cultural resources are as follows:

- The number of known prehistoric and historic sites to be affected and number of acres to be disturbed by mining exploration and development.
- Changes in settings or visual qualities that contribute to the integrity of cultural resource sites (evaluated qualitatively) and the degree to which reclamation practices can be used to restore the settings of sites.

Current Value Resource Condition Indicators

Although it is difficult to know the current condition of all of the cultural resources in the three proposed withdrawal parcels, sites adjacent to existing access roads have likely been subject to the greatest levels of direct damage and are likely more vulnerable to theft and vandalism. Erosion of archaeological sites caused by newly graded roads and increased vehicular activity may also result in the loss of integrity.

Archaeological site vandalism is a serious problem throughout the western United States. The Kaibab National Forest and the BLM have recorded incidents of site vandalism, particularly at highly visible sites such as pueblos, historic buildings, and other structures. Unfortunately, since many sites have yet to be fully recorded or re-inspected, the total amount of vandalism may not be ascertainable. That said, because of the remote nature of many of the sites, it is likely that many sites have not been vandalized.

3.12 AMERICAN INDIAN RESOURCES

The term American Indian resources refers to places, which may include archaeological sites, that are regarded as important to Indian cultures and traditions. These places may be individual landforms or larger geographic features, they may be places associated with sacred beings or ancestors, or they may be places where people came and still come to hunt game or to gather plant resources. Several laws and policies protect American Indian resources:

- The National Historic Preservation Act [16 USC 470] created the NRHP and the Section 106 process, which requires federal agencies to consider the effects of their actions on historic properties, including places of traditional religious and cultural importance to Indian tribes.
- The American Indian Religious Freedom Act [PL 95-341; 42 USC 1996] establishes a national policy to protect the right of American Indians and other indigenous groups to exercise their traditional religions.

- EO 13007, Indian Sacred Sites, was designed to accommodate access to American Indian sacred sites on federal land and to avoid harm to these sites "to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions."
- NEPA requires assessing potential impacts of a federal undertaking to the human environment, including places of cultural importance, consistent with the stated policy to preserve important cultural aspects of our national heritage.

3.12.1 Traditional Cultural Values and Practices

American Indians in the Southwest have an intimate relationship with their traditional territories, especially that of the Grand Canyon area (Fairley 2004; Hirst 2006; Stoffle et al. 2005). For the purposes of this analysis, the term Grand Canyon area encompasses the Grand Canyon, the proposed withdrawal area, and the lands immediately adjacent to both; however, precise boundaries cannot be established at this time because what is considered the "Grand Canyon area" will vary across tribes. Many groups see their history and culture as being bound and expressed in the landscape. Often, certain places were shaped by the actions of ancestors or spirit beings, or these beings and their actions are embodied in natural features and landmarks. All of these beliefs mean that for American Indians their traditional territories contain places that are of "traditional religious or cultural importance" [NHPA (16 USC 470)]. Some of these places are considered by tribes to be TCPs which a federal agency may determine as eligible for the NRHP. TCPs are places that are connected to "those beliefs, customs, and practices of a living community of people" (Parker and King 1998). TCPs generally embody values, beliefs, or practices that are widely shared within the group and have been passed down through generations. To be determined eligible for the NRHP, a property must meet one or more of the legal eligibility criteria. Few properties have received formal evaluations. This EIS addresses potential impacts to places that tribes define as traditionally important regardless of their NRHP eligibility status.

One NRHP-eligible TCP, Red Butte, is located within the South Parcel. However, many places within the proposed withdrawal area may have qualities that would render them eligible for the NRHP as TCPs.

Data on places important to some tribes within the withdrawal parcels are presently available for the following American Indian groups: Southern Paiute (Las Vegas Paiute Tribe, Kaibab Band of Paiute Indians, Moapa Band of Paiute Indians, Pahrump Paiute Indian Tribe, Paiute Tribe of Utah, which includes the Shivwits Band of Paiute, and San Juan Southern Paiute Tribe), Havasupai Indian Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe, and Pueblo of Zuni.

Southern Paiute

The Southern Paiute today consist of the Kaibab Band of Paiute Indians, San Juan Southern Paiute, Paiute Indian Tribe of Utah, which includes the Shivwits Band of the Paiute, Moapa Band of Paiute Indians, and Las Vegas Tribe of Paiute Indians. Before the arrival of European-Americans, the Southern Paiute were primarily hunter-gatherers who practiced a limited amount of cultivation. Their traditional territory extended from the Grand Canyon north into Utah and Nevada.

For the Southern Paiute and other Numic language speakers everything in the world has *puhu* (power) (Stoffle et al. 2005). Puhu permeates everything and "is why everything is alive, has a will, and is capable of action" (Stoffle et al. 2005:19). Puhu connects all things and can move throughout the world. The Southern Paiute consider all of their traditional territory sacred because it is connected to stories of mythic beings (Franklin and Bunte 1994). For example, the San Juan Paiute believe that people came about when Coyote opened a quiver that was given to him by Ocean Grandmother. All the different peoples emerged out of the quiver, with the Paiute being last. Coyote opened the quiver southeast of the

Colorado River, which is considered the San Juan Paiute's homeland and the center of the world (Franklin and Bunte 1994).

The reservation of the Kaibab Band of Paiute Indians borders the northern border of the North Parcel, and they are the most intimately connected of the Southern Paiute bands to the proposed withdrawal area. Both the North and East parcels are part of their traditional homeland and have been used by them for as long as they can remember. Several important traditional sacred and cultural places for the Kaibab Band of Paiute Indians are located within the boundaries of the proposed withdrawal area.

Havasupai Tribe

The Havasupai Tribe today occupy a 185,000-acre reservation located within Havasu Canyon and up onto the Coconino Plateau; however, their traditional territory stretched from the Colorado River to Bill Williams Mountain and from the Aubrey Cliffs to the Little Colorado River and included the entire South Parcel (Schwartz 1983). Traditionally, Havasupai lived within the Havasu Canyon, which is within the Grand Canyon, in the summer and on the plateau in the winter. Havasupai farmed the canyon bottom in the summer and relied on hunted and gathered resources from the plateau in the winter.

According to their beliefs, the Havasupai peoples emerged from the earth in the Grand Canyon in search of light (Tilousi 1993). Havasupai origin tales tell of a time when the people lived beneath the earth and had no light to hunt by (Smithson and Euler 1994:36; Tilousi 1993). Two brothers traveled through a hole in the earth and acquired the sun and the moon for the people. The Havasupai believe that the Canyon, the surrounding plateau, and all the plants and animals were given to them to care for. They believe themselves to be a part of the Grand Canyon and that they cannot be separated from it (Hirst 2006:207). The Havasupai have tales about many of the landforms in and around the Grand Canyon, including landforms within the proposed withdrawal area. It is important to the Havasupai that they are asked "about the sacredness of the area, about places where the bone of our ancestors are buried" (Tilousi 1993).

Hualapai Tribe

Before the arrival of European-Americans, the Hualapai Tribe's traditional territory stretched from the Colorado River south to the Bill Williams River and from the Black Mountains east to Havasu Canyon (McGuire 1983). According to their stories, the Hualapai, along with the Havasupai and Yavapai, were created in the west at Wikame or "Spirit Mountain" by two brother deities (Fairley 2004). All the Pai peoples then journeyed to the Grand Canyon, led by the older of the two brothers, who taught them all they needed to survive in the area (Kroeber 1935:15–26; Hualapai Tribe 1993; Stevens and Mercer 1998 cited in Fairley 2004:66). They all lived together until a children's fight led to the three tribes' splitting up; the Hualapai and Yavapai parted ways, and the Havasupai moved into the Grand Canyon.
The Grand Canyon and the surrounding areas are regarded as sacred to the Hualapai. Many of the landforms are connected to stories about the ancestors, with the river and the Grand Canyon serving as the "backbone" or Ha' Yi-Data (Hualapai Tribe 1993; Stevens and Mercer 1998, cited in Fairley 2004:66; Whatoname 2009).

Navajo Nation

The Navajo traditional territory extends from just west of the Rio Grande in New Mexico to the Colorado River in Arizona and from north of the San Juan River to just south of the Little Colorado River (Brugge 1983). The Navajo consider the Colorado River itself as sacred and a source of power; it also represents the westernmost boundary of Navajoland (Roberts et al. 1995, cited in Fairley 2004:69–70). According to Navajo stories, the Navajo emerged from earth after they had traveled through several underground worlds (Gill 1982, 1983; Klah 1942; Stephen 1930). Violence and conflicts that sometimes led to destruction caused them to seek a new world each time. Once they had emerged onto the current world's surface, they were in Dinetah, or their traditional homeland, which is bordered by four sacred mountains. These mountains are associated with the cardinal directions and are located at each of the four corners of the world (Gill 1982). Many of the mountains and other landforms seen today were created by the actions of sacred beings after the Navajo emerged from the worlds below. The Navajo have a story about how each place came to be; the association of traditional territory with the sacred beings and their actions makes the entire area sacred to the Navajo. These places include archaeological sites throughout their traditional territory, as these were the homes of their ancestors. Navajo ceremonies, songs, prayers, and sandpaintings all reference these ancestral places.

Hopi Tribe

The Hopi traditional territory extends over the entire state of Arizona. The Hopi, along with all other people, emerged into the current world, the Fourth World, from the Third World at a place called Sipapuni located in the Grand Canyon (Fairley 2004; Nuvamsa 2008). Upon emerging into the Fourth World, the Hopi were met by Maasaw, the Earth Guardian, who charged the Hopi with the care of the earth. The different peoples left the Sipapuni and journeyed toward the east (Vecsey 1983). Some stopped and settled for a while before moving east again; these are the builders of the ruins seen throughout the land (Stephen 1929; Vecsey 1983). The Hopi finally settled on Black Mesa; each of the clans arrived separately. Although the Hopi currently do not live near the Grand Canyon, it is the origin place of their people, and they see themselves as stewards of the earth, including the Grand Canyon and the proposed withdrawal area (Ferguson 1997; Nuvamsa 2008).

Pueblo of Zuni

The traditional territory of the Pueblo of Zuni extends into both Arizona and New Mexico. Like the Hopi, the Zuni emerged into the Fourth World in the Grand Canyon. Once they emerged, they were told to seek the "middle place;" once they arrived there, they could settle and build their town (Ferguson and Hart 1985:21–23; Gill 1982). The Zuni traveled for several years and tried to settle in a few places. Each time, their village was destroyed or they decided to move because the location was deemed not to be the middle place (Gill 1982; Parsons 1923). The Zuni eventually asked a series of animals to help them locate the middle place; finally, a water strider found the place and told the Zuni to settle beneath his heart (Parsons 1923). Like the Hopi, the Zuni are intimately connected to Grand Canyon, and, like the Hopi, the ruins found in the area are the towns of their ancestors (Ferguson and Hart 1985:21–23).

3.12.2 American Indian Use Areas

The following discussion is based on research of sources available to the public, as well as a report on important ethnographic resources within the proposed withdrawal area commissioned by the NPS (Hedquist and Ferguson 2010). The following information is entirely from published sources unless otherwise noted. Because of the sensitive nature of some information provided by tribes not found in published literature, some areas may not be discussed in detail.

In addition to the places described below, because of association with their ancestors, American Indians often consider prehistoric and historic sites as significant. Most American Indians prefer that archaeological sites not be disturbed and that access to them be limited in order to prevent vandalism.

Colorado Plateau

The Colorado Plateau, both north and south of the Grand Canyon, is regarded by many tribes as a traditional cultural landscape extending back thousands of years. The concept of 'cultural landscape' or 'ethnographic landscape' is taken from scholarly literature and is used in the EIS exclusively in this sense. These terms are not intended to imply any kind of landscape level protection. Within the Colorado Plateau, there are several smaller areas, as well as specific places that are of concern to one or more tribes for traditional, cultural, or sacred reasons. Several studies have detailed the traditional ethnographic landscapes of the Southern Paiute on the Arizona Strip, although the area has also been used by other groups (Austin et al. 2005; Stoffle et al. 1997; Stoffle et al. 2005). These studies have identified several sensitive areas in both the North and East parcels, as well as areas immediately adjacent to the proposed withdrawal area. The places important to the Southern Paiute vary in size and shape and are not necessarily mutually exclusive. In addition, the Havasupai have expressed cultural concerns about the Kanab Plateau during consultation.

The lands that form the South Parcel represent traditional use areas for several tribes: Southern Paiute, Hualapai, Havasupai, Hopi, Navajo, Yavapai, and Pueblo of Zuni. These tribes share concern for the entire area, as well as specific locations within the parcel, which reflect long-term use and overlapping territories.

Many of the important landscapes and places are connected with water. For example, the Southern Paiute consider the Colorado River the "blood vein of the earth" (Stoffle et al. 2005). Other creeks and rivers are smaller veins that are "water connection places," which link all parts of the land to one another (Stoffle et al. 2005). Springs, as water sources, also are special places. According to Kelly (1964:11–13), springs could be "owned" by Paiute family groups, who would camp there over the course of their seasonal cycle.

Trails served as important communication and trade routes for many different peoples throughout the proposed withdrawal parcels. Many trails followed important water sources or served as pilgrimage routes. Other important areas include places used for traditional hunting and gathering. Kelley (1964) identified several areas within all three proposed withdrawal parcels that were used for various subsistence activities by the Southern Paiute. She identified economic clusters/seasonal cycles and areas used for specific resource procurement activities. Kelly defined these economic clusters/seasonal cycles based on spring location and how groups traveled from spring to spring in order to collect seasonal resources (Kelley 1964:11, 22–23). The lands in the North and East parcels were used primarily by the Southern Paiute; the lands of the South Parcel were used by the Hopi, Havasupai, and Navajo for subsistence (Hedquist and Ferguson 2010). These areas are not defined as economic clusters/seasonal cycle areas but are considered traditional use areas.

In addition, there are specific religiously and culturally significant places throughout the three proposed withdrawal parcels. These places may be considered sacred to one or more tribes and used for ceremonial, as well as other, purposes.

GRAND CANYON REGION LANDSCAPE

The Grand Canyon region landscape stretches from Navajo Mountain and the Kaibab Plateau in the east to the Beaver Dam Mountains to the west and from the Paunsaugunt and Markagunt plateaus in the north and the Colorado River in the south, and it is the largest of the Paiute traditional landscapes. The boundaries encompass "the watersheds that drain into the Colorado River" (Stoffle et al. 1997). The Grand Canyon, known as Piapaxa 'uipi or "Big River Canyon," is the "central focus of . . . [the] landscape" (Stoffle et al. 1997); however, the Grand Canyon regional landscape consists of myriad connected places throughout the entire area (Stoffle et al. 1997). Importantly, the region represents the extent of the traditional Paiute seasonal movement prior to the arrival of Europeans.

North Parcel

KANAB CREEK ECOSCAPE

The Kanab Creek ecoscape stretches from Bulrush and Hack Canyon washes in the east to Snake Gulch to the west and from the confluence of Kanab Creek with the Colorado River in the south to the Pink Cliffs in the north. Like the Grand Canyon region landscape, the Kanab Creek ecoscape is defined by watersheds (Stoffle et al. 2000). The Kanab Creek watershed falls within the traditional territory of the Kaibab Band of the Paiute, who farmed along the creek and exploited the various plant and animal resources available throughout the area (Stoffle et al. 1997; Stoffle et al. 2000). The Kanab Creek ecoscape was also an important north-south trade route and served as a refuge for Paiutes during European-American encroachment (Stoffle et al. 1997; Stoffle et al. 2000).

KANAB CREEK AND THE COLORADO RIVER

Although they are included in the above landscapes, the Kanab Creek and Colorado River are themselves considered significant places to the Paiute, especially to the Kaibab Band of the Paiute. The Southern Paiute Consortium considers these and “the whole region in and around Grand Canyon as an indivisible Traditional Cultural Property” (Southern Paiute Consortium 2010). For the Navajo, the Colorado River is thought of as a TCP since it plays a role in their creation stories (Molenaar 2005:17). The Zuni and the Hopi emerged in the Grand Canyon from the previous worlds. Although the Zuni consider the confluence of the Little Colorado and Colorado rivers a TCP, the entire Grand Canyon and river habitat are “integrally connected to Zuni religious beliefs, ceremonies, and prayers” (Dongoske 2009:2).

KANAB CREEK GHOST DANCE SITE

A rock art site associated with the Ghost Dance is located within the Kanab Creek Canyon at an unpublished location (Stoffle et al. 2000). The site consists of pictographs painted on and petroglyphs pecked into a sandstone outcrop. It has likely been used for more than 2,000 years. The Kaibab Paiute have identified one panel of white figures as being associated with the Ghost Dance ceremony, which was performed in the late nineteenth century (Stoffle et al. 2000). The Ghost Dance was a revitalization movement that began among the Paiute in Nevada but quickly spread throughout tribes in Northern Arizona and Utah and into the Great Plains (Kehoe 1989).

SPRINGS

Three springs located within the North Parcel are important to the Southern Paiute. Moonshine Spring is located just west of Bulrush Wash, Wa’akarerempa or Yellowstone Spring is located on Yellowstone Mesa, and Tinkanivac or Antelope Spring is located in Antelope Valley (Austin et al. 2005:79; Hedquist and Ferguson 2010:9; Kelley 1964:8). Moonshine and Yellowstone springs also have several archaeological sites associated with them. The Moonshine Ridge ACEC encompasses Moonshine Spring and its associated archaeological sites.

TRAILS

Several trails cross the North Parcel. Along Kanab Creek, a trail stretches from the northern edge of the parcel to the Grand Canyon. The Kanab Creek trail was the Paiute’s “entrance” into the canyon (Stoffle et al. 2005:182). Another trail ran from the spring Tinkanivac to the Colorado River (Kelley 1964:88; Stoffle et al. 1994:76).

Although not specifically mentioned in the literature, access routes to culturally significant places south of the parcel must also be considered. Mt. Trumbull, Toroweap, Vulcan's Anvil, and several springs, which are all part of Paiute traditional territory, are located just outside the southwest corner of the parcel. Access to these areas is primarily through the North Parcel. Modern access is via roads; however, the existence of trails to this area has been documented in the ethnographic literature. Many modern roads and trails follow ancient American Indian trails through the North Parcel. During consultation, the Hopi Tribe indicated that several places north of the Grand Canyon, including Mt. Trumbull, have traditional cultural importance. The Hopi travel through the North and East parcels to reach places of ritual importance north of the Grand Canyon.

ECONOMIC/SUBSISTENCE AREAS AND TRADITIONAL TERRITORIES

Both the traditional territories Kaibab and Uinkaret bands of the Southern Paiute occur within portions of the North Parcel (Kelley 1934:548, 551). Kelley (1964) identified the Economic Cluster/Seasonal Cycle I as extending from Moonshine Spring north into the current Kaibab Paiute Reservation (Kelley 1964:11). Other important resource procurement areas include an antelope hunting range in Antelope Valley (Austin et al. 2005:3, 80; Kelley 1934:554; Kelley and Fowler 1986:369) and a mescal gathering location along Kanab Creek (Austin et al. 2005:3; Kelley 1934:554; Kelley and Fowler 1986:369).

East Parcel

HOUSE ROCK VALLEY (AESAK LAND)

The Paiute called House Rock Valley Aesak or "basket-like" (Austin et al. 2005:57). The entire valley was used by the Paiute to gather plant resources and to hunt animals. Although House Rock Valley was traditionally the territory of the Kaibab Paiute, the San Juan Paiute were allowed to collect seeds in the fall. In return, the Kaibab Paiute could collect seeds in the summer from the territory of the San Juan Paiute. As part of this agreement, the host group would hold a round dance for the visitors; the dance allowed continued interaction between the groups and often led to intergroup marriages (Bunte and Franklin 1987:19).

KANE RANCH (OARINKANIVAC AND PAGAMPIAGANTI)

Two springs important to the Paiute sit on the Kane Ranch property: Oarinkanivac and Pagampiaganti. Families would camp at these springs seasonally when foraging for resources (Kelly 1964:10–12).

HOUSE ROCK VALLEY TRAILS

Trails are also an important component for the Paiute of the House Rock Valley (Stoffle et al. 2005). For example, what is now known as the Mormon Honeymoon Trail was once an American Indian trail along the Vermilion Cliffs. This trail accessed several important spring sites along the cliffs, including Deer and House Rock springs. This trail and the sites along it should be considered a connected resource.

Another trail running from Kane Ranch to the Colorado River connects the springs to the Grand Canyon near the location of the Hopi Salt Mine (Kelley 1964:89; Stoffle et al. 1994:76).

ECONOMIC/SUBSISTENCE RESOURCE AREAS

The Paiute Economic Cluster/Seasonal Cycle VIII and Economic Cluster/Seasonal Cycle IX extend into the East Parcel in the north (Hedquist and Ferguson 2010:12, 65–66; Kelley 1964:11–22). Both of these are associated with springs along the Vermilion Cliffs; the Economic Cluster/Seasonal Cycle IX is also associated with Kane Ranch and the two springs located there. Also, areas for hunting deer and antelope are located in the valley (Austin et al. 2005:3; Ferguson and Hedquist 2009:8; Kelley 1934:554; Kelley and Fowler 1986:369).

In addition to the places and landscapes discussed above, several important places are directly adjacent to the proposed withdrawal area and should be considered. These include several sites along the Vermilion Cliffs (including the California condor release site, West Bench Pueblo, Signature Rock, and Jacob's Pool), as well as Vasey's Paradise (personal communication, J. Balsom, Grand Canyon National Park 2010).

South Parcel

RED BUTTE

Red Butte is located in the southern portion of the South Parcel and is a known sacred site for the Havasupai, Hualapai, Navajo, Hopi, and Zuni. The Forest Service has determined that Red Butte is eligible for listing in the NRHP as a TCP for its association and importance to American Indian beliefs and ceremonialism. The Forest Service has worked with the above named tribes to document Red Butte's importance as a gathering place for trade and ceremonialism for the tribes. In addition, the tribes have expressed concern in the past for the travel corridor from Red Butte north to the Grand Canyon (personal communication, J. Balsom, Grand Canyon National Park 2010).

NAVAJO CULTURAL LANDSCAPE

The South Parcel is within the Navajo Nation's traditional claim area (Hedquist and Ferguson 2010:249). Within that claim area lies the Coconino Plateau cultural landscape known as Dzil Libáí or Grey Mountain (Linford 2000:69). The area was used mainly in the nineteenth century and served as a battlefield for conflicts between the Navajo and Mexicans (Linford 2000:69). In the South Parcel, the number of archaeological sites of the Historic period attributed to the Navajo (99) indicates that they were regularly using the area. Most of these sites, scattered throughout the parcel, are the remains of sweat lodges and other shelters. These may have been temporary camps associated with hunting, other activities, or periodic travel to the Grand Canyon from the homeland. In addition, a Navajo ceremonial site is located on the Coconino Plateau, but its exact location is unknown (Hedquist and Ferguson 2010:14; Roberts et al. 1995:91).

HOPI TRADITIONAL USE AREA

The Hopi traditional use area or claim area covers the entire state of Arizona, which includes the South Parcel (Hedquist and Ferguson 2010:251; Kuwanwisiwma and Ferguson 2010).

HUALAPAI TRADTIONAL TERRITORY

The Hualapai have long used and continue to use the South Parcel for settlement, hunting and gathering, gardening, trade, and travel. In oral histories, Hualapai elders describe birth places as well as gatherings near Red Butte with the Hopi, Havasupai, and other tribes. Trails were important in maintaining social, kinship, and trade relations with other tribes. Items traded by the Hualapai to other groups included tanned deer hides and red paint (hematite). Hualapai place names east of the South Parcel reflect the close relationships between the Hualapai and the western area of Hopi settlements around present-day Moenkopi.

TRAILS

A network of trails crosses the South Parcel, connecting the Hopi and Zuni with the Havasupai and Hualapai. These trails generally run east-west and extend well beyond the boundaries of the parcel. Some trails run all the way from the Rio Grande Pueblos to the Pacific Ocean. Many of these trails can be seen on early General Land Office maps from the turn of the century. The best known trails are those that run from Hopi Mesa to the Grand Canyon and the territory of the Havasupai. At least one trail leads past Red Butte on its way to the Grand Canyon (Colton 1964). Two Navajo trails used to access the canyon and Havasupai territory are found in the northern portion of the South Parcel (Roberts et al. 1995:73–74). These trails not only represent long-distance trade, but also long-standing and important social and kinship relations between the Hualapai, Hopi, and other tribes.

HAVASUPAI SEASONAL CAMPS

The Havasupai traditional use area encompasses the South Parcel (Hedquist and Ferguson 2010:252). Two Havasupai seasonal camps are located in the northern portion of the South Parcel: one is located near Hull Tank; the other is at Rain Tank. The area around Hull Tank is used for pinyon collection while the camp at Rain Tank was primarily associated with trade with the Hopi and Navajo (Manners 1974:106; Wray 1990:19, 46).

SPRINGS

The Hualapai and Havasupai consider all springs in the South Parcel and surrounding areas to be sacred, and the health and vitality of these springs is vital to the well-being of the people and all living beings.

Natural Resources

Many plant and animal species found the proposed withdrawal area are important to the cultural and religious practices of American Indian tribes. For example, the bald eagle figures prominently in many American Indian cultures. Several plant species are gathered within the proposed withdrawal area. The Hualapai harvest Kaibab agave (*Agave utahensis* var. *kaibabensis*) from areas near and within the proposed withdrawal area. Other plant species important to the Hualapai found in the proposed withdrawal area are listed in Table 3.12-1.

Table 3.12-1. Plants Important to the Hualapai in the Proposed Withdrawal Area

Plant	Scientific Name	Plant	Scientific Name
Algerita	*Berberis fermontii*	Big Sagebrush	*Artemisia* sp.
Apache Plum	*Fallugia paradoxa*	Black Walnut	*Juglans maior*
Arizona Ash	*Flaxinus velutina*	Black Willow	*Salix* spp.
Arizona Manzanita	*Arctostaphylos* sp.	Burrobrush	*Hymenoclea* sp.
Arrow weed	*Pluchea sericea*	Catsclaw	*Acacia* sp.
Banana Yucca	*Yucca baccata*	Cattail	*Typha* sp.
Barrel Cactus	*Ferocactus* sp.	Cholla	*Opuntia* sp.
Beargrass	*Nolina* sp.	Cliffrose	*Cowinia mexicana*

Table 3.12-1. Plants Important to the Hualapai in the Proposed Withdrawal Area (Continued)

Plant	Scientific Name	Plant	Scientific Name
Cottonwood Tree	*Populus* sp.	Ponderosa Pine	*Pinus ponderosa*
Creosotebush	*Larrea tridentata*	Prickly Pear	*Opuntia* spp.
Desert Willow	*Chilopsis lineris*	Reed	*Phragmites comminus trin.*
Devil's Claw	*Proboscidea parviflora*	Seep Willow	*Baccharis spp.*
Dock, Wild Rhubarb	*Rumex hymenosepalus Ton.*	Shrub Live Oak	*Quercus turbinella*
Filaree	*Erodicum* sp.	Snakeweed	*Gutierrezia* spp.
Four Winged Salt Bush	*Atiplex* spp.	Soapweed	*Nolina parryi*
Gambel Oak	*Quercus gambelii*	Squawberry	*Rhus trilobata*
Globemallow	*Sphaeralcea* sp.	Stick Leaf	*Mentzelia* spp.
Indian Tea, Mormon Tea	*Ephedra* spp.	Sunflower	*Helianthus* spp.
Juniper	*Juniperus* sp.	Wild Mulberry	*Morus* sp.
Mescal agave	*Agave* sp.	Wild Onion	*Allium* spp.
Mesquite	*Prosopis* sp.	Wild Onion/Turnip	*Cymoqterus* spp.
Milkweed	*Asclepias* spp.	Wild Tabacco	*Nicotiana trigonophylla*
Mohave Yucca	*Yucca mohavensis sarg.*	Wild Tomato	*Physalis* spp.
Netleaf Mexican Locust	*Robina neomexicana*	Wildgrape	*Vitis* sp.
Ocotillo	*Fouquieria* spp.	Yerba Santa	*Eriodictyon angustifolium*
Piñon Pine	*Pinus edulis*		

Source: Adapted from Watahomigie et al. (1982).

Trust Resources and Assets

BLM Manual Handbook H-8120-1, *Guidelines for Conducting Tribal Consultation* (BLM 2004), defines Indian trust assets as "lands, natural resources, money, or other assets held by the Federal Government in trust or restricted against alienation for Indian tribes and individual Indians (Secretarial Order No. 3215, April 28, 2000). Trust is a formal, legally defined, property-based relationship that depends on the existence of three elements: (1) a trust asset (lands, resources, money, etc.); (2) a beneficial owner (the Indian tribe or individual Indian allottee); and (3) a trustee (the Secretary of the Interior)."
There are no Trust Resources or Assets located within the proposed withdrawal parcels.

3.12.3 Resource Condition Indicators

Resource condition indicators for traditionally important places are not easily definable or quantifiable. The importance of landscapes and places can be understood through a group or individual's "sense of place." Sense of place refers to how people experience and understand a location; the experience and understanding are a product of one's cultural history and values, such that different groups can experience the same place in different ways (Allen et al. 2009; Farnum et al. 2005). Sense of place is tied to group and individual emotions and backgrounds, making it difficult to define and even harder to quantify.

When dealing with places of traditional heritage, the analysis of possible impacts is dependent on the emotional and intellectual response of the concerned groups and individuals. It is, in essence, their reaction and opinions alone that determine whether there is an impact and the relative significance of that impact. Indicators include the following:

- The proximity and size of possible surface, visual, or auditory disturbance to, or within, identified TCPs.
- Number of acres of total possible disturbance by mineral exploration and development.
- Proximity of traditional use areas to anticipated mineral exploration and development.
- Likelihood of concurrent or overlapping timing of traditional activity with mineral exploration and development.
- Manner and degree of auditory or visual disruptions in the traditional use area.
- Number and types of traditional cultural use areas, sacred sites, and trails that could be disturbed by mineral exploration and development.

3.13 WILDERNESS RESOURCES

3.13.1 Wilderness

Permanent wilderness protection for federal lands comes only through Congressional action that creates “statutory” or “designated” wilderness areas. Such lands are managed under the mandates of the Wilderness Act of 1964 [16 USC 1131–1136] and any special management instructions that Congress may include in the specific legislation that “designates” specific wilderness areas. The Wilderness Act dictates that wilderness areas are managed to protect and preserve their “wilderness character.”

Congressional intent for the meaning of wilderness character is expressed in the Definition of Wilderness, Section 2(c) of the 1964 Wilderness Act. The BLM, Forest Service, NPS and other agencies apply the legal definition to identify four tangible qualities of wilderness that make up the description of wilderness character relevant and practical to wilderness stewardship:

- **Untrammeled:** The Wilderness Act states that wilderness is “an area where the earth and its community of life are untrammeled by man” and “generally appears to have been affected primarily by the forces of nature.”
- **Natural:** The Wilderness Act states that wilderness is “protected and managed so as to preserve its natural conditions.” Wilderness ecological systems are substantially free from the effects of modern civilization.
- **Undeveloped:** The Wilderness Act states that wilderness is an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, “where man himself is a visitor who does not remain” and “with the imprint of man’s work substantially unnoticeable.”
- **Solitude or a primitive and unconfined type of recreation:** The Wilderness Act states that wilderness has “outstanding opportunities for solitude or a primitive and unconfined type of recreation.”

There are three wilderness areas immediately adjacent to the proposed withdrawal area: Kanab Creek (which is jointly managed by the BLM and Forest Service and is adjacent to the North Parcel); Paria Canyon–Vermilion Cliffs (jointly managed by the Arizona Strip Field Office and Utah BLM, and adjacent to the East Parcel); and Saddle Mountain (managed by the Forest Service and adjacent to the East Parcel).

The Arizona Wilderness Act of 1984 designated these three areas. The Arizona Wilderness Act released certain BLM lands in the Arizona Strip and KNF lands from further wilderness review. The Act specifies that areas not designated wilderness shall be managed for multiple uses; that the creation of protective perimeters or buffers for uses up to the boundary of the wilderness area is not the intention of the Act; and that the wilderness designations would be subject to valid existing rights. Importantly, the Act did not preclude future reviews for wilderness or other conservation uses by the Secretary.

The three wilderness areas within or immediately adjacent to the proposed withdrawal area currently provide a standard of solitude and naturalness that ranges from good to outstanding. They contain little to no evidence of surface disturbance, other than former vehicle ways and scattered prospects. Federal lands within wilderness areas are closed to mineral entry, subject to valid existing rights. No valid mineral discoveries have been documented in any of these wilderness areas.

Lands that have the tangible qualities of a wilderness but that have not been designated a wilderness by an act of Congress are sometimes managed to maintain wilderness characteristics. Wilderness characteristics are discussed and analyzed in Sections 3.14 and 4.14 of this FEIS.

Kanab Creek Wilderness

The Kanab Creek Wilderness is managed jointly by the BLM and Forest Service in accordance with the *Kanab Creek Wilderness Implementation Schedule* (BLM and Forest Service 1988) and covers 70,460 acres. The Kanab Creek Wilderness straddles the Mohave–Coconino county line and is contiguous along about 14 miles of its boundary with NPS lands in Grand Canyon National Park. The Kanab Creek Wilderness is located on the eastern border of the North Parcel and is part of the largest canyon system on the north side of the Grand Canyon. It includes impressive rock formations, colorations, and features carved by wind and water. Numerous springs provide an interesting contrast with the generally arid terrain. The cliffs are home to bands of desert bighorn sheep as well as peregrine falcons.

Paria Canyon–Vermilion Cliffs Wilderness

The Paria Canyon–Vermilion Cliffs Wilderness is managed by the BLM in accordance with the *Paria Canyon–Vermilion Cliffs Wilderness: Wilderness Management Plan* (BLM 1986c) and covers 112,500 acres. The wilderness is located approximately 10 miles west of Page, Arizona, in Coconino County, Arizona, and Kane County, Utah. The wilderness is located along the northern border of the East Parcel. Nationally known for its beauty, Paria Canyon has towering walls streaked with desert varnish, huge red rock amphitheaters, sandstone arches, wooded terraces, and hanging gardens. The 3,000-foot escarpment known as the Vermilion Cliffs dominates the remainder of the wilderness with its thick Navajo sandstone face, steep, boulder-strewn slopes, rugged arroyos, and stark overall appearance. Desert bighorn sheep and peregrine falcon inhabit the area.

Saddle Mountain Wilderness

The Saddle Mountain Wilderness contains a total of 40,539 acres and is managed by the Forest Service. The wilderness straddles the eastern edge of the Kaibab Plateau and is located southwest of the East Parcel. Three permanent springs in North Canyon and one in South Canyon provide water and a gathering place for the local inhabitants, including pronghorn antelope, blue grouse (*Dendragapus obscures*), small mammals, and a buffalo herd. Trailheads that access the wilderness originate at the top of the Kaibab Plateau and at its base in House Rock Valley. The Saddle Mountain Trail parallels the main ridge for approximately 4 miles and rewards hikers with views of the Marble Canyon Gorge, Cocks Comb, House Rock Valley, and the Vermilion Cliffs. It also provides access into Grand Canyon National Park. The North and South canyon trails, 7 and 4 miles long, respectively, follow canyon bottoms.

Proposed Wilderness

A wilderness proposal was prepared for Grand Canyon National Park in 1980; it was updated in 1993 and awaits further action. It proposed a wilderness designation for 1,109,257 acres, with an additional 29,820 acres of potential wilderness within Grand Canyon National Park, pending the resolution of Park boundary and motorized riverboat issues. These areas offer visitors opportunities for solitude and primitive recreation. The management of these areas should preserve the wilderness values and character (NPS 1995).

The 2006 *NPS Management Polices* and Director's Order 41 require that proposed wilderness areas be managed the same as designated wilderness and that no actions be taken that would diminish wilderness suitability until the legislative process for wilderness designation has been completed. Therefore, NPS manages all proposed wilderness areas as wilderness and anticipates the final resolution of wilderness issues and the preparation of a wilderness management plan as future actions. NPS policies address wilderness management as well as management of threats to park resources (NPS 2006b). The NPS-proposed wilderness is managed under the wilderness character attributes described in Section 3.13.1.

Nonwilderness undeveloped areas continue to serve primarily as primitive thresholds to wilderness. Areas currently excluded from proposed wilderness inside the Grand Canyon National Park include 1) several dirt roads throughout the Park; 2) the area on the South Rim from Hermits Rest to Desert View; 3) Bright Angel Point on the North Rim (300 feet on either side of paved roads and 150 feet on either side of unpaved roads); 4) the Tuweep developed area; and 5) the corridor trails.

3.13.2 Resource Indicators

The wilderness resource condition indicators used to characterize wilderness are those indicators that reflect the wilderness characteristics that supported the wilderness designation, as described in Section 3.13.1: land that is untrammeled, natural, undeveloped, and offers solitude or a primitive and unconfined type of recreation (Table 3.13-1).

Table 3.13-1. Wilderness Resource Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator
Wilderness areas	Designated wilderness is already withdrawn from location and entry under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to designated wilderness areas, which may affect wilderness resources.	*Indicator*: Changes in the land's tangible wilderness qualities: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.

3.14 WILDERNESS CHARACTERISTICS

Federal lands that possess the tangible qualities of a wilderness but that have not been designated a wilderness by an act of Congress are sometimes managed to maintain certain wilderness characteristics. Certain areas of adjacent federal lands, including Grand Canyon National Park, Grand Canyon–Parashant National Monument, and Vermilion Cliffs National Monument, are managed to maintain wilderness characteristics (Figure 3.14-1). The BLM Arizona Strip Field Office, Kaibab Tusayan Ranger District, and NPS all provide management direction in their respective land management plans for wilderness characteristics; this direction is discussed in detail below.

BLM maintains wilderness resource inventories on a regular and continuing basis for public lands under its jurisdiction. BLM Instructional Memo (IM) 2003-275 directs the BLM to protect wilderness characteristics through land use planning and project-level decisions unless the BLM determines, in accordance with IM 2003-275, that impairment of wilderness characteristics is appropriate and consistent with other applicable requirements of law and other resource management considerations.

As discussed below, the proposed withdrawal includes both lands possessing wilderness characteristics as well as lands managed to maintain wilderness characteristics; primarily within or adjacent to the North and East parcels. The analysis area for wilderness characteristics includes the proposed withdrawal areas, and extends to adjacent public lands that possess wilderness characteristics: lands within the Arizona Strip Field Office, Grand Canyon–Parashant National Monument, Vermilion Cliffs National Monument, and Grand Canyon National Park.

3.14.1 Resource Indicators

The wilderness characteristics resources condition indicators used to characterize the potential impacts to wilderness characteristics are the qualities for which the wilderness is designated: land that has a high degree of naturalness, an outstanding opportunity for solitude, and an outstanding opportunity for primitive and unconfined recreation (Table 3.14-1). BLM, KNF, and NPS all have guidelines and/or policies in place to manage for wilderness characteristics.

Table 3.14-1. Wilderness Characteristics Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator
Wilderness characteristics	Lands possessing or managed to maintain wilderness characteristics may not already be withdrawn from location and entry under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to lands possessing or managed to maintain wilderness characteristics, which may result in changes to the land's wilderness characteristics.	*Indicator*: Changes in the land's wilderness characteristics: high degree of naturalness, outstanding opportunities for solitude, or outstanding opportunities for primitive and unconfined recreation.

3.14.2 Bureau of Land Management

BLM IM 2003-275 presents the guidelines for managing wilderness characteristics. BLM IM 2003-275 states, "The BLM may consider information on wilderness characteristics, along with information on other uses and values, when preparing land use plans." Table 3.14-2 provides an overview of wilderness characteristics for BLM lands in the Affected Environment, including Vermilion Cliffs National Monument and Grand Canyon–Parashant National Monument (BLM 2008b).

Table 3.14-2. Overview of BLM Wilderness Characteristics

Lands Possessing Wilderness Characteristics	Acreage	Lands Managed to Maintain Wilderness Characteristics	Acreage	Lands Managed to Maintain Wilderness Characteristics within the Proposed Withdrawal Area	Acreage
Arizona Strip Field Office	158,033	Arizona Strip Field Office	34,764	Arizona Strip Field Office	12,846
Grand Canyon Parashant National Monument*	440,899	Grand Canyon Parashant National Monument*	215,345	Grand Canyon–Parashant National Monument*	0
Vermilion Cliffs National Monument	97,380	Vermilion Cliffs National Monument	34,566	Vermilion Cliffs National Monument	0
Totals	**696,312**		**284,675**		**12,846**

Sources: BLM (2008b, 2008e, 2008f); NPS (2008).

* Grand Canyon–Parashant National Monument Includes NPS acreages.

The Arizona Strip Field Office (BLM 2008b) identified approximately 34,764 acres of land adjacent to Kanab Creek Wilderness that possess naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation—characteristics of land described in BLM IM 2003-275 as land containing wilderness characteristics. BLM and NPS lands that possess the above values may be managed to maintain or enhance some or all of those characteristics (BLM 2007).

As described in Table 3.14-2 and illustrated in Figure 3.14-1, there are approximately 12,846 acres of BLM lands managed to maintain wilderness characteristics within the proposed withdrawal area. This acreage includes the Grama and Hack Canyon areas, which are adjacent to Kanab Creek Wilderness. Grama Canyon's lands that are managed to maintain wilderness characteristics total approximately 7,109 acres; Hack Canyon's lands that are managed to maintain wilderness characteristics total approximately 5,737 acres. These areas are managed to maintain the following wilderness characteristics:

- High Degree of Naturalness: Lands and resources affected primarily by the forces of nature and where the imprint of human activity is substantially unnoticeable.
- Outstanding Opportunities for Solitude: When the sights, sounds and evidence of other people are rare or infrequent and where visitors can be isolated, alone or secluded from others.
- Outstanding Opportunities for Primitive and Unconfined Recreation: Where the use of the area will be through non-motorized, non-mechanical means, and where no or minimal developed recreation facilities are encountered.

There are no lands managed to maintain wilderness characteristics within the East Parcel. BLM lands that are managed to maintain wilderness characteristics outside the withdrawal area include 215,345 acres within Grand Canyon–Parashant National Monument (Grand Canyon–Parashant National Monument is jointly managed by BLM and NPS; therefore, this acreage includes NPS lands); 37,566 acres within Vermilion Cliffs National Monument; and 21,916 acres of Arizona Strip Field Office land. In addition, other regional BLM field offices in Washington and Kane counties, Utah, may manage lands to maintain wilderness characteristics.

3.14.3 Forest Service

The KNF is currently undergoing a Forest Plan Revision. Through the Forest Plan Revision, Forest Service Manual and Handbook directives provide guidance about wilderness evaluation and management for the Forest Plan revision.

The KNF Forest Plan revision has not designated any lands to be managed to maintain wilderness characteristics (personal communication, Liz Schuppert, Forest Service 2011) within the Tusayan Ranger District, which includes the South Parcel.

3.14.4 National Park Service

According the 1995 Grand Canyon National Park General Management Plan, more than 1 million acres in the Park meet the criteria for wilderness designation as part of the national wilderness preservation system (see Figure 3.14-1). These areas proposed for wilderness, although not designated wilderness, are managed as wilderness by the Park. In addition, the Colorado River corridor and adjacent lands are managed as proposed potential wilderness, totaling approximately 12,900 acres (personal communication, Linda Jalbert, NPS 2011).

Additional NPS lands managed to maintain wilderness characteristics outside the withdrawal area include 215,345 acres within Grand Canyon–Parashant National Monument (Grand Canyon–Parashant National

Monument is jointly managed by BLM and NPS; therefore, this acreage includes BLM lands) (NPS 2008).

3.15 RECREATION RESOURCES

Recreation activities occurring throughout northern Arizona, including in the proposed withdrawal area and the adjacent Grand Canyon, involve a broad spectrum of pursuits, ranging from dispersed and casual recreation to organized, BLM- and Forest Service–permitted group uses. Typical recreation in the region includes OHV driving, scenic driving, hunting, hiking, wildlife viewing, horseback riding, camping, backpacking, mountain biking, geocaching, picnicking, night-sky viewing, and photography. The region is known for its large-scale undeveloped areas and remoteness, which provide a wide variety of recreational opportunities for users who wish to experience primitive and undeveloped recreation, as well as those seeking more organized or packaged recreation experiences. Figure 3.15-1 provides an overview of recreation in and surrounding the proposed withdrawal area.

The affected environment is based on defining the existing conditions of recreation resources using the management guidelines from the Arizona Strip ROD/RMP (BLM 2008b) and Kaibab LMP/ROD (Forest Service 1988).

3.15.1 Recreation Resource Attractions

A vast network of improved and primitive roads, although remote and often requiring high-clearance vehicles, offers a variety of opportunities for driving for pleasure or vehicle exploring. Some of these roads were constructed for mining purposes, and, in some cases, are still used for mining, in addition to public recreation. Figure 3.15-1 illustrates the recreation attraction, including GMUs, campgrounds, overlooks, interpretive sites, and trailheads. Figure 3.15-2 illustrates the existing transportation and access network in the proposed withdrawal area. Remnants of historic trails, such as the Honeymoon Trail, Dominguez-Escalante Route, and the recently designated Old Spanish National Historic Trail, lie within the Arizona Strip. Both the Arizona Strip Field Office and Tusayan Ranger District of the Kaibab National Forest are currently working on revising route designations through separate NEPA processes. The resultant route designations will likely differ from the existing network described in Table 3.15-1 and illustrated in Figure 3.15-2.

The vast majority of BLM lands and the proposed withdrawal area are without formally constructed trails for foot, horse, bike, or motorcycle. Therefore, exploration of its roadless areas via off-route foot or horse travel requires exceptional navigation and outdoor skills. Table 3.15-1 describes the uses of existing routes within the proposed withdrawal area. The Tusayan Ranger District of the Kaibab National Forest has several constructed trails, including the Arizona Trail, a recently designated National Scenic Trail. Table 3.15-1 describes existing routes within the proposed withdrawal area.

Table 3.15-1. Existing Routes within the Proposed Withdrawal Area: Mileage Summary by Use and Maintenance Level

Use Designation	Example of Recreation Use	Miles
Paved roads	Scenic driving, heritage touring	70.64
Unpaved roads	Scenic driving, recreational vehicle use, heritage touring, horseback riding, mountain biking, hiking	2,497.57
Closed roads	Horseback riding, hiking	0.62
Reclaimed roads	Hiking	23.94
Total		**2,592.77**

Sources: BLM (2010f); Forest Service (2010b).

The proposed withdrawal area includes various lands managed to maintain the wilderness characteristics of naturalness, solitude, and opportunities for primitive recreation. These characteristics are defined as follows.

Naturalness: Lands and resources exhibit a high degree of naturalness, are affected primarily by the forces of nature, and are areas in which the imprint of human activity is substantially unnoticeable. The BLM has authority to inventory, assess, and/or monitor the attributes of the lands and resources on public lands, which, taken together, are an indication of an area's naturalness. These attributes may include the presence or absence of roads and trails, fences and other improvements, the nature and extent of landscape modifications, the presence of native vegetation communities, and the connectivity of habitats.

Outstanding Opportunities for Solitude: Visitors may have outstanding opportunities for solitude when the sights, sounds, and evidence of other people are rare or infrequent and where visitors can be isolated, alone, or secluded from others.

Outstanding Opportunities for a Primitive and Unconfined Type of Recreation: Visitors may have outstanding opportunities for primitive and unconfined types of recreation where the use of the area is through non-motorized, non-mechanical means and where no or minimal developed recreation facilities are encountered.

The fact that many of these areas typically include unique scenic beauty and diverse landscape settings increases their recreational quality (BLM 2008b). Recreation sites illustrated in Figure 3.15-1 include trailheads, overlooks and vistas, wildlife viewing areas, camp and picnic grounds, and interpretive sites. These recreation sites are detailed in Table 3.15-2.

Table 3.15-2. Inventory of Recreation Sites and Visitor Data within the Proposed Withdrawal Area

Proposed Withdrawal Area	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)*
East Parcel	Forest Service	House Rock Valley Overlook Interpretive Site	Interpretive site	5,371
East Parcel	Forest Service	Navajo Trail	Trailhead	N/A
East Parcel	BLM	Soap Creek	Trailhead	328
East Parcel	BLM	Rider Canyon	Trailhead	36
East Parcel	BLM	North Canyon Creek	Trailhead	36
East Parcel	BLM	Badger Creek	Trailhead	120
East Parcel	BLM	Dominquez-Escalante Interpretive Site	Historic Site	10,635
East Parcel	BLM	Condor Interpretive Site	Wildlife/Overlook	4,200
North Parcel	BLM	Hack Canyon	Trailhead	402
North Parcel	BLM	Swapp Trail	Trailhead	N/A
North Parcel	Forest Service	Gunsight Point	Overlook	N/A
North Parcel	Forest Service	Hatch Cabin	Cabin	N/A
North Parcel	BLM	Rock Canyon	Trailhead	N/A
South Parcel	Forest Service	Ten-X Family Campground	Family Campground	N/A
South Parcel	Forest Service	Charlie Tank Group Camp Ground	Group campground	N/A
South Parcel	Forest Service	Tusayan Bike Trails	Trailheads	N/A
South Parcel	Forest Service	Arizona Trail	Trailhead	N/A
South Parcel	Forest Service	Red Butte	Trailhead	N/A
South Parcel	Forest Service	Russell Tank Fishing Parking Area	Fishing site	N/A

Table 3.15-2. Inventory of Recreation Sites and Visitor Data within the Proposed Withdrawal Area (Continued)

Proposed Withdrawal Area	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)*
Outside Withdrawal Area	NPS	Bass Trail	Trailhead	N/A
Outside Withdrawal Area	NPS	Kanab Point	Overlook	N/A
Outside Withdrawal Area	NPS	150 Mile Canyon	Trailhead	N/A
Outside Withdrawal Area	Forest Service/NPS	South Canyon	Trailhead	54
Outside Withdrawal Area	NPS	SB Point	Overlook	N/A
Outside Withdrawal Area	NPS	Grand Canyon Gateway	Park entrance	4,418,773
Outside Withdrawal Area	NPS/BLM	Tuckup Point	Overlook	N/A
Outside Withdrawal Area	NPS	Toroweap	Campground/Overlook	3,859

Sources: BLM (2009b); Forest Service (2009e); NPS (2009b).

Note: Access to some recreation sites on public lands adjacent to the proposed withdrawal and in Grand Canyon National Park requires users to travel on routes that occur within the proposed withdrawal area; these are therefore considered in this analysis.

* Land management agencies do not track public visitation at some recreation sites.

The open landscapes provide long-distance vistas easily viewed from both paved and unpaved routes. The entire segment of U.S. 89A through the Arizona Strip Field Office is designated by the State of Arizona as a state scenic road. The Arizona Department of Transportation (ADOT)is currently analyzing the potential of U.S. 89A for designation as a National Scenic Byway (personal communication, Richard Spotts, BLM 2010). The segment, along with the other paved routes mentioned, is part of the multiple-partner Vermilion Cliffs Highways Project, which is an initiative to provide interpretive signs at approximately 23 sites (BLM 2008b).

Grand Canyon National Park manages adjacent lands on the North Parcel and the Marble Platform in House Rock Valley (areas adjacent to the Park in the East Parcel are known as the Marble Platform) to maintain its current undeveloped character. These areas are zoned by the Park as Primitive (NPS 1988). NPS zoning does not apply to activities on adjacent multiple-use lands.

3.15.2 North and East Parcels

Existing Recreation Activities

The plains, plateaus, mountains, cliffs, and sweeping scenery of the Arizona Strip provide a wide range of opportunities for dispersed, moderately regulated recreation. Exploration, driving for pleasure, hiking, backpacking, camping, picnicking, big- and small-game hunting, wildlife observation, and competitive and organized group events are the most common activity types. Motorized or mechanized vehicle use, walking, or horseback riding are typical modes of travel.

Current recreation setting conditions in the proposed withdrawal area range from primitive to rural, with most of the land being semi-primitive motorized and roaded natural. No urban settings are present directly on BLM-administered lands.

Recreation Management—Resources, Signage, and Recreation Facilities

The proposed withdrawal area (North and East parcels) are accessed by a network of unpaved BLM and Forest Service routes. Many are primitive and can be rough much of the year. This system of routes provides a variety of backcountry driving opportunities and access to key destinations and features. Popular routes include the Toroweap Road, Big Springs Road, and BLM Route 8910 (see Figure 3.15-2).

Access to the remote areas within these parcels offers both the hardy, outdoor adventurer and the sightseeing tourist a wide variety of primitive roads that provide outstanding opportunities for 4-wheel-drive (4WD) and all-terrain vehicle (ATV) exploring and driving opportunities to key destinations and features or for just enjoying the variety of recreation activities. Exploration of most of the backcountry areas within the proposed withdrawal area requires excellent navigational, outdoor and, in some places, canyoneering skills (BLM 2008b).

Few formally constructed non-motorized trails are present in the North and East parcels. Other hiking routes in the proposed withdrawal area tend to take advantage of canyon bottoms, such as Soap Creek, Rider and Hack canyons, or old cattle and sheep trails, such as around the Navajo Trail, Arizona Trail, or ridgelines and old roads.

There are no developed camping facilities within the North and East parcels of the proposed withdrawal area. At-large and dispersed camping occurs at many existing primitive or undeveloped sites along existing roads, trails, and spur roads or trails.

Various small interpretive sites, such as the Dominguez-Escalante Site, Condor Release Interpretive Site, and a variety of single interpretive signs are scattered throughout the area, for example at House Rock Valley Overlook and along the historic Honeymoon Trail.

Visitors typically enjoy the area year-round (although access in the winter can be difficult because of mud and/or snow).

The community interface areas see the greatest variety of recreation users and the highest day-use visitation rates (BLM 2008b) in the proposed withdrawal area. Table 3.15-2 shows annual visitation numbers (where available). Because of the remote nature of much of the area and the dispersed nature of most recreation activities in which visitors engage, it is difficult to obtain actual numbers of most visits to the North and East parcels. For example, no reliable visitor data exist for backcountry camping and OHV use, although these activities frequently take place. The estimates for BLM visitor use are based on data collected from various traffic counters, registration sheets, and professional assumptions determined by data collected on field patrol. No social surveys have been conducted for BLM lands within the proposed withdrawal area.

Motorized activities in these areas are popular and increasing, along with the demand for more opportunities. For instance, local community groups envision the potential to establish formal networks of OHV and/or motorcycle routes connecting various communities in the Arizona Strip (BLM 2008b).

The 2009 Recreation Management Information System (RMIS) data show that BLM lands managed by the Arizona Strip Field Office received approximately 182,564 visitors in 2009. The RMIS numbers are generated by strategic traffic counters and visitor sign-in kiosks. The RMIS results for recreation use of the Arizona Strip by recreation activity showed results that were similar to those of the Kaibab’s National Visitor Use Monitoring Program (NVUM) data, discussed in Section 3.15.3. Interpretation, nature study, and education were the most frequent recreation activities, with approximately 50% of the 2009 visitors engaging in some form of this (BLM 2009b). Scenic driving/viewing was the second-most common recreation activity in the Arizona Strip, with approximately 26% of the 2009 visitors engaging in some form of scenic viewing/driving for pleasure. Table 3.15-3 illustrates the recreation activity in 2009 for the Arizona Strip.

Table 3.15-3. Arizona Strip Field Office Visitor Use Activity Groupings for 2009

Visitor Use Activity	No. of Participants	Visitor Days
Camping and picnicking	24,778	13,937
Driving for pleasure	48,343	24,172
Hunting	2,421	8,062
Interpretation, education, and nature study	92,439	4,900
Non-motorized travel	7,480	3,398
OHV travel	1,813	806
Specialized non-motor sports, events, and activities	5,288	1,271
Winter/non-motorized activities	2	1
Total	**182,564**	**56,547**

Source: BLM (2009c).

3.15.3 South Parcel

The recreation study area for Forest Service lands within the proposed withdrawal area includes the South Parcel, which encompasses the Tusayan Ranger District of the Kaibab National Forest. The Kanab Creek Wilderness, located adjacent to the North Parcel, is jointly managed by the BLM and the Forest Service. The East Parcel also includes Kaibab National Forest land along the western boundary of the parcel.

The Tusayan Ranger District is bordered on the east by the Navajo Reservation, where the rugged Coconino Rim drops off toward the Little Colorado River. To the south, Red Butte dominates the landscape. This volcanic hill is a remnant of past volcanic activities and has cultural significance for many American Indian tribes. With its close proximity to several tribes, the Tusayan Ranger District is an important area for forest product gathering as well as for traditional and ceremonial uses.

The Tusayan Ranger District lies to the south of Grand Canyon National Park. Millions of visitors from the United States and abroad pass through the Tusayan Ranger District every year. The Ten-X Campground offers basic amenities and close proximity to the Grand Canyon. Mountain bikers, hikers, and equestrians enjoy the Arizona National Scenic Trail, which crosses the South Parcel from south to north and passes into Grand Canyon National Park (see Figure 3.15-1). There are backcountry camping, scenery, and wildlife viewing opportunities. The Tusayan Ranger District is known for its trophy-sized elk. There are excellent hunting opportunities for deer, elk, and pronghorn antelope (Forest Service 1988). Many people gather fuel wood for both personal and commercial use. Christmas tree cutting is a popular winter activity (Forest Service 2009g).

Visitors have different motivations for the activities in which they want to participate and preferences for the recreation setting in which they like to recreate. For some forest visitors, traveling on a scenic developed or primitive road with friends or family is ideal. For other forest visitors, visiting remote areas where the signs of human development are absent is ideal. With recognition of such differences in user preferences, the primary aim of managing outdoor recreation is to provide an environment in which visitors can enjoy a satisfying experience in a range of settings.

Existing Recreation Activities

Recreation activities within the Tusayan Ranger District (South Parcel) are similar to those within the Arizona Strip. Unique landscapes, climate, vegetation, and wildlife provide a wide array of recreation opportunities. Developed recreation sites are uncommon in the Tusayan Ranger District (Forest Service

2009g). Exploration, driving for pleasure, hiking, backpacking, camping, picnicking, big- and small-game hunting, wildlife observation, and competitive and organized group events are the most common activity types. Motorized or mechanized vehicle use, walking, or horseback riding are typical modes of travel.

Current recreation setting conditions in the Forest Service lands within the proposed withdrawal area range from Primitive to Rural. No urban settings are present; however, the proposed withdrawal area interfaces with the community of Tusayan (see Figures 3.15-1 and 3.15-3, depicting key attraction sites and recreation settings, respectively).

Recreation Management—Resources, Signage, and Recreation Facilities

The South Parcel of the proposed withdrawal area has approximately 1,892 miles of maintained, unpaved Forest Service roads and trails (Forest Service 2010b). Many are primitive and can be rough much of the year. This system of roads and trails provides a variety of backcountry driving opportunities and access to key destinations and features (see Figure 3.15-2).

Access to these remote areas offers both the hardy, outdoor adventurer and the sightseeing tourist a wide variety of primitive roads that provide outstanding opportunities for 4WD and ATV exploring and driving opportunities to key destinations and features or for just enjoying the variety of recreation activities.

Red Butte, the Arizona Trail, and the Tusayan Bike Trails are among the few formally constructed trails for foot, horse, or bike in the Tusayan Ranger District of the proposed withdrawal area.

There are two developed camping facilities within the South Parcel of the proposed withdrawal area. Ten-X Campground, and Charlie Tank Group Campground are all located along the Grand Canyon Gateway corridor along U.S. 180/SR 64 (see Figure 3.15-1). Dispersed camping occurs at many existing primitive or undeveloped sites along existing routes and spur routes.

The 2005 NVUM report (the best available visitation data) estimated that the Kaibab National Forest received up to 225,000 annual visits to recreation facilities in 2005. Among these site visits, most visitations occurred in undeveloped areas; these areas were also the sites for stays of the longest duration, as shown in Table 3.15-4.

Table 3.15-4. Duration of Visits to Kaibab National Forest

Visit Type	Average Duration (hours)	Median Duration (hours)
Site visit	19.3	3.7
Day use developed	2.7	2.0
Overnight use developed	26.9	18.8
Undeveloped areas	45.5	3.0
Designated Wilderness	10.5	4.3
National Forest visit	35.7	6.0

Source: Forest Service (2009e:FY 2005 data).

The most popular recreation activity for the Kaibab National Forest in 2005 was viewing natural features, with 54.7% of all visitors, followed by hiking and walking for pleasure, with 47.2%. Table 3.15-5 details recreation participation by activity in the Kaibab National Forest.

Table 3.15-5. Activity Participation on Kaibab National Forest

Activity	Total Activity Participation (%)*†	Main Activity (%)‡	No. of Respondents for Whom Main Activity§	Average Hours Spent Doing Main Activity (Hours)
Some other activity	26.1	22.6	206	4.3
Viewing natural features	54.7	17.2	76	6.5
Hiking/walking	47.2	12.0	97	4.4
Driving for pleasure	44.2	11.4	42	3.1
Viewing wildlife	44.8	5.8	18	7.1
Developed camping	13.7	5.4	65	23.7
Other non-motorized	8.3	5.4	71	8.0
Motorized trail activity	7.0	4.9	7	1.3
Hunting	4.9	4.6	9	42.0
Relaxing	36.7	3.7	49	23.4
Primitive camping	13.2	3.1	29	21.3
Bicycling	6.4	2.1	8	7.3
Fishing	3.6	1.6	9	7.9
Downhill skiing	1.6	1.4	43	3.2
Resort use	8.9	1.3	5	21.8
Visiting historic sites	21.5	1.2	6	3.8
Backpacking	2.8	0.9	5	10.4
Picnicking	12.4	0.8	5	8.8
OHV use	3.4	0.8	1	2.0
No activity reported	0.5	0.7	5	
Nature study	10.9	0.5	5	15.0
Horseback riding	2.4	0.2	1	5.0
Nature center activities	18.9	0.1	2	3.2
Non-motorized water	0.2	0.1	4	3.4
Cross-country skiing	0.1	0.1	3	4.0
Other motorized activity	1.7	0.0	0	
Gathering forest products	1.7	0.0	0	
Motorized water activities	0.3	0.0	0	
Snowmobiling	0.0	0.0	0	

Source: Forest Service (2009e:FY 2005 data).

* Survey respondents could select multiple activities, so this column may total more than 100%.

† The number in this column is the number of survey respondents who indicated participation in this activity.

‡ Survey respondents were asked to select just one of their activities as their main reason for the forest visit. Some respondents selected more than one, so this column may total more than 100%.

§ The number in this column is the number of survey respondents who indicated this activity was their main activity.

3.15.4 Recreation Opportunity Spectrum

Bureau of Land Management Recreation Opportunity Spectrum

Critical to producing recreation opportunities is the condition of recreation settings on which those opportunities depend. The condition of recreation settings is on a spectrum from Primitive to Urban and can be classified and mapped, based on the variation that exists in the various physical, social, and administrative attributes of any landscape. The physical setting describes variations in components such as remoteness, naturalness, and facilities. The social setting reflects the variations in components such as group size, number and types of contacts, encounters between individuals or groups, and the evidence of use by others. The administrative setting can reflect variations in the kind and extent of components such as visitor services, management controls, user fees, and mechanized use.

Forest Service Recreation Opportunity Spectrum

The Kaibab LRMP/ROD (Forest Service 1988) ROS mapping classified the Tusayan Ranger District in the Roaded Natural and Semi-primitive Motorized ROS classes. In 2003 and 2004, when ROS existing conditions were inventoried and re-mapped as part of the South Zone Recreation Desired Future Condition project, it was documented that some of the Roaded Natural areas have trended toward Roaded Modified and Rural ROS conditions, and some Semi-primitive Motorized and Semi-primitive Non-Motorized areas have changed to Roaded Natural and Roaded Modified ROS classes. The net result of the landscape's becoming more uniform appearing, more roaded, and more managed is a loss of a spectrum of available recreation settings and opportunities across the South Zone, particularly the Semi-primitive Motorized and Semi-primitive Non-motorized ROS settings. Although very limited and becoming even more so, there are still areas that meet Semi-primitive Motorized and Semi-primitive Non-motorized ROS class requirements on the Tusayan Ranger District. The loss of Semi-primitive Motorized and Semi-primitive Non-motorized ROS areas is usually considered irreversible (Forest Service 2004).

Recent survey results indicated recreation users (visitors and local residents) to the Tusayan Ranger District participate in a wide variety of recreation activities in a broad spectrum of recreation settings. Survey results also indicated that users have a preference for pursing recreation experiences and activities in more natural-appearing landscapes, consistent with Primitive, Semi-primitive Non-motorized, Semi-primitive Motorized, and Roaded Natural ROS class settings. The survey results demonstrated a growing gap between recreation visitors' demand for more natural-appearing ROS class settings and the trend toward more managed-appearing ROS class conditions (Forest Service 2004).

Using the ROS as a basis for classifying existing recreation setting character conditions, the proposed withdrawal area contains combinations of five out of the six recreation environments shown in Figure 3.15-3 and described in Table 3.15-6. They range from areas that are primitive, have low use, and involve inconspicuous administration to rural areas near communities with higher use and a highly visible administrative presence. The wide variety of moderately regulated recreation settings in the proposed withdrawal area greatly enhances the quality of recreation experience and benefit outcomes for most visitors.

Table 3.15-6. Recreation Opportunity Spectrum within the Proposed Withdrawal Area

ROS	Total Acreage
Primitive	452
Semi-primitive Non-motorized	108,715
Semi-primitive Motorized	594,455
Roaded Natural	286,145
Roaded Modified	12,792
Rural	2,104
Urban	518
No ROS designation	1,364
Total	**1,006,545**

Sources: BLM (2009d); Forest Service (2009f).

NPS Backcountry Zoning System

The Grand Canyon National Park backcountry lands, which are outside the proposed withdrawal area, are divided into Use Areas based on established patterns of use and resource management considerations. Use Area boundaries are defined according to identifiable topographic features, such as ridge tops and drainages.

To better guide management actions in the backcountry and to provide an opportunity for a wide variety of backcountry experiences, each Use Area is classified into one of four Management Zones: Corridor, Threshold, Primitive, or Wild (Figure 3.15-4). The zones provide different recreational opportunities and levels of resource protection. Use Areas on or accessed via the Kanab Plateau (North Parcel) and Marble Platform (East Parcel) are primarily zoned as Primitive.

3.15.5 Management Units

Management units are Geographic Areas (GAs) with similar resource management goals that are identified to better manage resources. The BLM and Forest Service are required to conduct projects consistent with management prescriptions developed for specific management units. Figure 3.15-5 shows the management units within the proposed withdrawal area.

Bureau of Land Management Lands

The BLM uses four management unit categories (Community, Corridors, Back Roads, and Outback) to guide land use decisions and provide access into specific GAs with similar landscapes, resources, and resource uses (BLM 2008b). These four management unit types range from “close to home” opportunities to “more primitive” and “self-directed” opportunities.

COMMUNITY MANAGEMENT UNIT (RURAL TRAVEL MANAGEMENT AREA)

BLM-administered lands within the Community Management Unit provide opportunities for community growth and development. These lands also offer the widest variety of recreation opportunities and provide short-term or day-use recreation activities “close to home.” Lands within the Community Management Unit may also provide resources, such as fuelwood and mineral materials, access to permitted commercial and recreation activities, and scenic backdrops or settings for communities.

Portions of the North and East parcels are within the Community Management Unit (BLM 2008b). These areas are concentrated along the northern border of the Arizona Strip, primarily around the communities of Colorado City, Fredonia, and Marble Canyon.

GEOGRAPHIC AREA 9—UPPER BASIN

Lands within GA 9 are situated across the northeastern portion of the South Parcel. The area contains sensitive travel corridors, including SR 64, and scenic features such as the Coconino Rim escarpment. Recreation features include the Arizona National Scenic Trail, Grandview Lookout Tower, cross-country ski trails, and historic sites. The area is managed to maintain Semi-primitive recreation opportunities. Open grasslands are scattered throughout the area and provide important forage areas for livestock and big game. The area has moderate to high potential for uranium and low potential for oil and gas (Forest Service 1988).

GEOGRAPHIC AREA 10—TUSAYAN FORESTLAND

Lands within GA 10 are located in the central section of the South Parcel. Recreation use within the area is moderate, with several areas of concentrated use. Use consists mostly of dispersed camping, hunting, and sight-seeing. Most of the area is grazed by cattle from late spring until fall. The area has moderate potential for uranium and other minerals (Forest Service 1988).

CORRIDORS MANAGEMENT UNIT (BACKWAYS TRAVEL MANAGEMENT AREA)

Lands within the Corridors Management Unit occur along major travel routes, providing, among other things, access to the Back Roads and Outback management units. They offer a variety of recreation opportunities. These areas also provide access opportunities for short-term or day-use recreation activities related to vehicle touring. In the North Parcel, BLM Roads 5, 109, 22, and U.S. 89A are located within the Corridors Management Unit. In the East Parcel, BLM Road 8910 and U.S. 89A are located within the Corridors Management Unit.

BACK ROADS MANAGEMENT UNIT (SPECIALIZED TRAVEL MANAGEMENT AREA)

Lands identified within the Back Roads Management Unit are characterized by predominantly natural or natural-appearing environments of moderate to large size with moderate probabilities of experiencing isolation from the sights and sounds of other people. These natural-appearing landscapes and open spaces contribute to high-quality visitor experiences. While concentrations of users will be low, evidence of other user will be relatively high. These lands may also provide resources such as fuelwood and mineral materials. Portions of the North Parcel and the western and northeastern portions of the East Parcel are within the Back Roads Management Unit (BLM 2008b).

OUTBACK MANAGEMENT UNIT (PRIMITIVE TRAVEL MANAGEMENT AREA)

Lands within the Outback Management Unit provide opportunities for undeveloped, primitive, and self-directed recreation opportunities. Lands classified as within the Outback Management Unit are characterized by predominantly natural or natural-appearing environments of moderate to large size. The lowest level of landscape modifications is expected, compared with the other management units. Remote settings, natural landscapes, solitude, and opportunities for primitive recreation are minimally impacted by human activity. Portions of the North Parcel and the eastern portion of the East Parcel are within the Outback Management Unit (BLM 2008b).

Forest Service Lands

The Kaibab National Forest is divided into 11 discrete GAs. All the land within a given GA is managed under the same emphasis to ensure consistency, efficiency, and integration of management practices across the GA. In addition to GAs, the forest is also divided into Land Use Zones that contain additional or special direction within one or more GA. All GAs are managed to attain resource management objectives and contribute to bringing desired conditions into being. All desired conditions focus on conservation of the ecosystem and the human environment. The Forest Service lands within the proposed withdrawal area are located within GAs 8–10, 12, and 16 and within Land Use Zones 21 and 22. GA 11, the Kanab Creek Wilderness, is adjacent to the North Parcel and described below for analysis purposes.

GEOGRAPHIC AREA 8—SOUTHERN TUSAYAN WOODLAND

Lands within GA 8 are situated across the southern portion of the South Parcel. The area contains sensitive travelways such as SR 64 and the Arizona National Scenic Trail, important scenic features such as the Red Butte proposed TCP, and recreation resources. The area is managed to maintain semi-primitive recreation opportunities. A major utility corridor crosses the southern portion of this GA. The area has high potential for uranium and low to moderate potential for oil and gas. Open grasslands are scattered throughout the area and provide important forage areas for livestock (Forest Service 1988).

GEOGRAPHIC AREA 12—WESTERN NORTH KAIBAB WOODLAND

GA 12 includes portions of the west, north, and east sides of the North Kaibab Ranger District of the Kaibab National Forest. A small strip of this GA is located along Kanab Creek and the eastern border within the eastern edge of the North Parcel. The area consists of moderate-use areas that occur along roads and access points overlooking the Grand Canyon. Several of these roads also lead to trailheads that provide access to Kanab Creek Wilderness and Grand Canyon National Park. The area is managed to maintain non-motorized recreation opportunities. Visually sensitive areas occur along U.S. 89A, Forest Road 422, the rim of the Grand Canyon, and several forest roads leading to points overlooking the Grand Canyon. Management activities in these areas are visually subordinate to the characteristic landscape. The area was removed from livestock grazing through a NEPA decision in 2001; the area has not been grazed by permitted livestock since the mid-1990s. The area has moderate to high potential for uranium; however, most of the area is closed to mineral entry and location, subject to valid existing claims (Forest Service 1988).

GEOGRAPHIC AREA SPECIAL AREA 11—KANAB CREEK WILDERNESS

Lands within GA 11 include the Kanab Creek Wilderness, located in the western part of the North Kaibab Ranger District of the Kaibab National Forest. The portion of Hack Canyon that is managed by the Forest Service, in the eastern portion of the North Parcel, is located within this GA. Use of this wilderness is low and is concentrated in Kanab Creek and Snake Gulch and along the trail system, which links the area to adjacent lands of Grand Canyon National Park. The area is managed for the VQOs of preservation background. The area has moderate to high potential for uranium and other minerals; however, the Arizona Wilderness Act of 1984 withdrew the area to mineral entry and location, subject to valid existing rights (Forest Service 1988).

GEOGRAPHIC AREA 16—EASTERN NORTH KAIBAB WOODLAND

Lands within GA 16 include the Buffalo Ranch and the extreme east side of the North Kaibab Ranger District of the Kaibab National Forest. The western portion of the East Parcel is located within this GA. Recreation use within the area is low; however, the Forest Service will provide extensive management of recreation, visual, and heritage resources. The area is grazed by cattle and bison. The area has moderate potential for uranium and other minerals (Forest Service 1988).

LAND USE ZONE 21—EXISTING DEVELOPED RECREATION SITES

This management area includes 15 major existing public- and private-sector developed recreation sites and other small sites, including trailheads and interpretive sites on the Kaibab National Forest. Two existing developed recreation sites are located in the South Parcel. All existing developed recreation sites are withdrawn to mineral entry under the mining laws. The VQO of partial retention for developed recreation sites allows management activities that remain visually subordinate to the characteristic landscape. Roads accessing developed recreation sites are maintained at Level 4 or higher (Forest Service 1988).

LAND USE ZONE 22—PROPOSED DEVELOPED RECREATION SITES

This management area includes areas that have been proposed to be developed into recreation sites. One proposed developed recreation site in the South Parcel is located along SR 64 in the northeastern portion of the parcel. Proposed recreation sites are open to mineral entry; however, it appears that none of the sites involve lands known to contain valuable mineral resources. The ultimate location of a proposed developed recreation site is generally based on a combination of desirable attributes of a given area. These sites are managed for the VQO of partial retention of foreground (Forest Service 1988).

3.15.6 Resource Condition Indicators

For recreation resources, condition indicators include visitor use by activity (primitive, dispersed recreation versus developed, motorized-based recreation); acres within the ROS designations; desired recreation experiences; and the miles, acres, or number of recreation sites that are currently designated in the proposed withdrawal area.

3.16 SOCIAL CONDITIONS

3.16.1 Overview

The study area for this analysis is defined to include the counties containing the proposed withdrawal areas (Coconino County and Mohave County in Arizona). The study area also includes nearby counties in southern Utah that might house substantial portions of the mining workforce that could be affected by the alternatives and/or which are likely to provide most of the economic services related to mining and tourism activity in and near the northern and eastern withdrawal areas (Garfield County, Kane County, Washington County, Utah). San Juan County, Utah was also included because it is the home of the only currently active uranium mill in the region (the White Mesa Mill in Blanding).

Several communities within these counties are more likely to be affected by the proposed alternatives than others. The largest communities in the study area, such as the cities of St. George, Utah and Flagstaff, Arizona have large populations and diversified economies. Any changes that might result from the proposed alternatives would be well within the range of typical annual fluctuations in population, employment, earnings and other social and economic metrics for these two communities—and consequently would not be likely to be noticeable (see Sections 4.16 and 4.17). The smaller communities in closest proximity to the proposed withdrawal areas (or to the mill where uranium would be processed) are the most likely to be noticeably affected by economic and demographic changes that could result from the alternatives, and are therefore the focus of the social and economic analyses, in combination with the county level data. These communities are listed below, and depicted in Figure 3.16-1.

Proximate to the North Parcel:

- Colorado City (Arizona)
- Fredonia (Arizona)
- Kaibab CDP (Arizona)
- Kanab (Utah)

Proximate to the East Parcel:

- Bitter Springs CDP (Arizona)
- Page (Arizona)

Proximate to the South Parcel:

- Tusayan CDP (Arizona)

Proximate to the existing uranium mill:

- Blanding (Utah)

In addition to the counties and communities described above, American Indian tribes who live within and adjacent to the withdrawal areas are also discussed; these include the Navajo Nation, Hopi Tribe, Hualapai Tribe, Havasupai Indian Reservation, and Kaibab Band of Paiutes. The Kaibab CDP is located on Kaibab Band of Paiutes tribal land. Some of the Navajo Nation chapters (chapters are local government subdivisions, or communities) proximate to the proposed withdrawal areas include Cameron, Bodaway, Tuba City, and LeChee. Hopi chapters in proximity to the withdrawal areas Moenkopi and West Dinnebito. Although the Navajo Nation and Hopi Tribe are composed of smaller chapters, the tribal demographic information is discussed for the overall tribe, not for the individual communities and chapters within each tribe.

Area Communities

Local community and residents value access to federal lands and resources for a variety of reasons, "whether for earning a living, traditional and subsistence uses such as personal woodcutting, or for recreating" (BLM 2005b:43). Communities located close to lands such as the Grand Canyon, Kaibab National Forest, and BLM lands (including national monuments) also have economies that are tied to these lands. Residents from elsewhere visit and/or relocate to these areas for what may be perceived to be a better quality of life attributable to the rural nature of communities in the study area, as well as potential recreation opportunities such as OHV use, big-game hunting, hiking/walking/running, backpacking, and viewing opportunities. This, in turn, generates more money, which is directed to local, regional, and state economies. Thus, there are economic benefits from tourist activity, as well as potential economic benefits associated with communities that can provide workers and derive other economic benefits from mineral exploration and development on study area federal lands.

Many area communities that have access to federal lands (such as BLM, Forest Service, and NPS lands) have strong ties to these lands; residents can form a strong sense of identity based on the cultural and geographic nature of the area. Following are social profiles of each county and community studied in this analysis, based on information in their respective community and economic development plans. Population and other demographic data for these communities are presented in the following section on "Demographics."

COCONINO COUNTY

Coconino County is the largest county in Arizona and second largest in the Nation covering approximately 12 million acres. The southern core of Coconino County holds roughly 75% of the population with 60% of the population living in the Flagstaff Regional Planning Area. In general, development throughout the county is rural and low density with large swaths of undeveloped land separating residences.

With elevations ranging from 1,300 to 12,600 feet amsl, the landscape in Coconino County supports a diversity of climatic conditions, wildlife, vegetation, and topography. Thus, preserving rural character is valued within the County. The current General Plan includes techniques to manage sprawl, preserve open space, and enhance the natural quality of environmentally sensitive lands through integrated conservation design to encourage more efficient land use through shared open space and smaller lot size.

Coconino County contains the Grand Canyon National Park in addition to nine nationally designated protected areas which draw significant recreational and tourist activity annually. A large portion of Coconino County's land area is Native American lands covering about 38% of land area, and is home to the Navajo, Hualapai, Hopi, and Havasupai Nations.

As the geographically largest county in Arizona, Coconino County has a diversity of landscape to support a range of economic development opportunities with the City of Flagstaff remaining the economic "hub" of the County.

The Coconino County General Plan provides a Conservation Framework which emphasizes that land use decisions be compatible with the natural potential of the site and the landscape. The Conservation Framework also outlines five ecological principles and eleven conservation guidelines to ensure that economic development provides diverse employment base and ensures the County's continued economic vitality. In addition, the General Plan addresses the growth element and states that the County has never actively sought new industry, though as new economic development opportunities are explored they should be in keeping with the following goals: consistency with rural character; preservation of the features of the natural environment; providing livable wages; and supporting of niche industries that use local resources responsibly.

Tourism is a major economic contributor as there are several tourist destinations that attract millions of visitors annually to Coconino County. The County General Plan encourages the exploration of expanding the role of tourism by pursuing opportunities in eco-tourism and ethno-tourism and by encouraging tourist-related development projects designed to minimize human impact on the environment, and showcase the County's unique natural features (Coconino County 2003).

Bitter Springs CDP

Located on U.S. 89 just south of the City of Page, Arizona, Bitter Springs is part of the Navajo Nation and is surrounded by Kaibab National Forest to the west, Vermilion Cliffs Monument and Paria Canyon to the north and the Grand Canyon National Park to the southeast. Bitter Springs is over 8 square miles with a population density of about 66 people/square mile. The population of Bitter Springs is largely Native American (98%) and the job base is predominantly manufacturing (52%) and construction (26%).

Fredonia

Located in Coconino County, Fredonia, Arizona is considered the northern gateway to the Grand Canyon National Park. At about 4,700 feet above sea level, Fredonia is located on the high desert plateau situated between the North Rim Village of the Grand Canyon and Grand Staircase-Escalante National Monument. Fredonia is characterized as a rural town that supports a diversity of recreational activities because of open landscape and scenic vistas.

As discussed in Section 4.17, since losing the mining and timber related jobs that once supported its economic base, the Town of Fredonia has struggled economically. Though the town is struggling economically, as discussed in Environmental Justice, this community does not meet the criteria for an environmental justice community; that is, the population does not exceed 50% minority, and does not meet the criteria used in this analysis for a low-income population. According to the U.S. Census, 7.6% of Fredonia residents (individuals) and 3.3% of families are living below the poverty level (Table 3.16-4).

Kaibab CDP

The Kaibab CDP is located on the tribal lands of the Kaibab Band of Paiutes, southwest of Fredonia, Arizona, off SR 389 (see Figure 3.16-1). The Kaibab CDP is located directly north of the North Parcel, near the Arizona-Utah border. The CDP covers approximately 190 square miles, with population density estimated to be 1.5 persons per square mile.

Page

The City of Page, Arizona was planned and developed for workers building the Glen Canyon Dam in 1957. Page is located at 4,300 feet amsl on Manson Mesa overlooking Wahweap Bay of Lake Powell. Page was incorporated in 1975 and its economy is primarily based on recreation as it is a gateway to Lake Powell, Grand Canyon National Park, as well as National Parks in Utah such as Bryce and Zion National Parks (City of Page, Arizona 2011). Energy generation facilities such as the Navajo Generating Station and Glen Canyon Dam provide additional employment within Page (City of Page, Arizona 2011).

The City of Page is actively seeking economic development opportunities in order to obtain new revenues, improve services, and raise the standard of living for its citizens. The City is currently encouraging economic development growth through the sale of available land with incentives for developers (City of Page, Arizona 2011).

Tusayan

Located less than 5 miles south of the Grand Canyon National Park and within Kaibab National Forest, Tusayan is the smallest town in Arizona at about 144 acres. Incorporated in 2010, Tusayan is considered a resort town accommodating tourists and recreationists destined for the Grand Canyon. Tourist amenities such as helicopter tours, lodging, and transportation are accessed in Tusayan. The Tusayan General Plan allows for industrial activities including mineral extraction subject to conditional use permitting (Town of Tusayan 2002).

MOHAVE COUNTY

Mohave County was one of the fastest growing counties in the nation from 1990 to 2000, with population growth occurring at about 65% within the decade. Growth is largely based on “snowbirds” or seasonal housing for the retired population. The median age in Mohave County is 8.7 years older than the Arizona state average. The economy within Mohave County was historically based on ranching, mining, and manufacturing but has now shifted to construction, trade, real estate, finance, service, and gaming.

Mohave County identifies short and long-term economic development goals within the General Plan by directly addressing the County’s reliance on the hotel/casino industry for employment. Within the mid-1980s through the 1990s, Mohave County experienced a rapid growth in employment due of the hotel/casino industry in Laughlin, Nevada. The majority of these jobs are low paying service sector jobs filled by Mohave County residents. However, the County is actively working with the business community to encourage investments and economic growth to support local residents. Mohave County’s General Plan also indicates that progressive economic growth compatible with County goals for environmental protection, planned urban development, and economic diversification are crucial to creating a more stable economic base. Diversification of the economy would mean decreasing local reliance on the hotel/casino industry, while increasing employment in other industries within the County. Mohave County has established goals, policies and implementation measures to support commercial and industrial development to promote a diverse and stable County economy (Mohave County 2010).

In addition, Mohave County is “well positioned” to attract tourist activity to destinations like Lake Havasu State Park, Lake Mead, Historic Route 66, Grand Canyon, the London Bridge, as well as other Native American, cultural, natural and scenic attractions (Mohave County 2010)

Colorado City

Colorado City is located within Mohave County, and was founded in 1913 by members of the Fundamentalist Church of Jesus Christ of Latter Day Saints. Colorado City encompasses about 10.5 square miles with a population density of about 317 per square mile. The median age of Colorado City is 14 years old. The largest single employer within Colorado City is the school district. Other employers include manufacturing plants and regional construction.

KANE COUNTY

Kane County, Utah encompasses about 3 million acres of remote and rugged land 90% of which is public land, including several nationally designated scenic places (e.g., Glen Canyon Recreational Area, Grand Staircase–Escalante National Monument, Bryce Canyon National Monument, etc). Kane County is characterized by extremes in elevation, vegetation, precipitation, and scenic vistas.

As discussed in Section 3.17, Kane County, like many rural areas in southern Utah, has experienced economic struggles as natural resource extraction jobs diminished and were replaced by lower-paying hospitality jobs (Kane County 2011). The economy of Kane County has traditionally been based upon the natural resources found in the county, specifically agriculture. Within the last two decades significant decreases is agricultural production has negatively affected the population and economy. Additionally, within the last decade approximately one-third of new construction is seasonal housing adjacent to national parks and other recreational areas.

Major economic development goals outlined in the County's General Plan (Kane County 1998) are summarized as follows: "Kane County will be an active partner with other governments to foster a sustainable, broad-based economy which allows traditional economic uses to remain vibrant, while fostering new economic activities which expand economic opportunity, utilize available natural resources, and protect important scenic and social qualities" (Kane County 1998:11). Economic development issues for "tourist resources" and the "natural resources base" are detailed below.

In terms of the natural resources base, an economic development issue identified in the Kane County General Plan is "the ability to utilize the natural resources of the county in a responsible manner without undue political interference" (Kane County 1998:48). In terms of tourist resources, County economic development issue focus on "Tourism program development to date is unbalanced and needs to be rounded out with a concentrated effort to make Kane County a major destination hub under the banner of 'Utah's Park Central' for all classes of travelers to the area" (Kane County 1998:47).

Kanab

Kanab, Utah, located within Kane County and serving as the County Seat is unique in that it is surrounded by Grand Canyon National Park, Bryce Canyon National Park, Zion National Park, Lake Powell National Recreation Area, Grand Staircase-Escalante National Monument, Pipe Springs National Monument, Coral Pink Sand Dunes State Park, and Cedar Breaks National Monument.

Though Kanab has a long economic history, the economy is currently based on seasonal residents, tourism and recreation. Due to its scenic views and unique landscape character, hundreds of films have been made within Kanab giving it the moniker "Little Hollywood". Although the city benefits economically from tourism and recreation activity, the national recession has been pronounced in the City of Kanab, where sales-related tax revenues have diminished by approximately 16% since 2008 (see Section 3.17).

Currently, Kanab's General Plan indicates that overarching goals for planning include managing growth and capitalizing on its unique identity and location (Kanab 2007). Located within Kane County, principles outlined in CEBA's Economic Development Plan (CEBA 2009) are also supported by Kanab, with a particular focus on the economic health of the city.

WASHINGTON COUNTY

Washington County, located in southern Utah, has an elevation that ranges between 2,178 and 10,194 feet above sea level. The BLM is the largest land holder within Washington County, which has multiple highly visited recreational destinations including Zion National Park, Old Spanish Trail or Mountain Meadows, and Dixie National Forest. The County's scenic resources make it attractive to visitors and travelers that travel through the area.

Washington County has experienced significant and rapid growth over the last three decades and has the fifth-highest job growth rate in the U.S. Initially, farming and ranching along with some silver mining were the primary economic drivers of the region. Later, when Zion National Park was established, it marked the beginning of tourism as a significant sector in the local economy (see Section 3.17).

The County's General Plan acknowledges that "The economic and ecological health of the county is very much dependent on the manner in which public lands are managed by the various state and federal agencies having jurisdiction over 84% of lands within the county" (Washington County 2010:11). The County has struggled with regulations enforced by federal land managers such as the BLM and Forest Service and the effect of regulation on ensuring that local governments can provide for the health, safety, and welfare of their communities.

GARFIELD COUNTY

Garfield County is located in southern Utah and encompasses approximately 5,208 square miles. The County is the most rural county in the state, and describes itself as one of the most economically disadvantaged (Fischer, personal communication, August 31). The landscape within the county includes large swaths of open desert as well as nationally designated scenic places such as Bryce Canyon National Park, Grand Staircase–Escalante National Monument, Capital Reef National Park, and a portion of Canyonlands National Park (Garfield County, Utah 2011). Garfield County is also home to the Shootaring Canyon Mill, and inactive mill located near Ticaboo, Utah. In fact, approximately 95% of the County's 5,000+ acres are managed by the government. Like Washington County, because the vast majority of Garfield County is comprised largely of public lands, public lands policies have a tremendous effect on the County.

Garfield County considers themselves a disadvantaged community, particularly in terms of low-income workers. The County's workforce consists of a major segment of low-income workers, including U.S. Citizen and Immigration Services H-2B non-agricultural temporary workers (foreign nationals) (Fischer, personal communication, 2011). Although the County describes themselves as a low-income community, as discussed in Environmental Justice, Garfield County does not meet the criteria used in this analysis for an environmental justice community; that is, the population does not exceed 50% minority and does not meet the criteria for a low-income population. According to the U.S. Census, 10.8% of County residents (individuals) and 6.7% of families are living below the poverty level (see Table 3.16-4).

Like other counties in Southern Utah in the study area, Garfield County's economy has expanded from an agriculture-based and natural resource extraction focus to one which includes industry, retail and tourism, and other service-oriented businesses (Garfield County 2007). It is important to note that between 2000 and 2008, the largest increase in employment was attributed to the mining industry (Garfield County 2010). In fact, the county boasts a relatively diverse employment base (Garfield County 2010:46).

Economic development goals for Garfield County are focused on maintaining a strong and diverse economic base. Additionally, economic development goals include recognizing the importance of tourism in the regional economy, and encouraging diverse tourism related development (Garfield County 2010).

SAN JUAN COUNTY

San Juan County is located in southeastern Utah and is approximately 7,933 square miles in area. San Juan County is characterized by a variety of landscape types, with elevations ranging from 3,000 to 13,000 feet above sea level as well as nationally-designated scenic areas such as Cedar Mesa, Comb Wash, Hovenweep National Monument, Canyonlands National Park, and a portion of Glen Canyon National Recreational Area. San Juan County also has several oil and gas producing fields produced from Desert Creek and Ismay formations as well as the only operating uranium processing plant located in Blanding, Utah.

Like Washington County, farming, ranching, and silver mining were the primary economic drivers of the region. Establishment of Zion National Park marked the beginning of tourism as a significant sector in the local economy (see Section 3.17). Like Garfield County, “San Juan County has a somewhat diverse economic base and employment profile” (San Juan County 2008:33).

Private lands in the county only account for 8% of area lands; thus, like Garfield County, public lands policies have a tremendous effect on the county’s economy and quality of life (San Juan County 2008). In fact, one of the county’s “Desired Conditions” in the Master Plan is: “It is San Juan County’s desire that the negative impact of federal agencies decisions on San Juan County communities, economies, and residents are minimized.” Planning and implementation should include possible mitigation measures to avoid identified negative impacts” (San Juan County 2008:21).

Blanding

Blanding, Utah is the most populated city in San Juan County. Blanding serves as a gateway to several natural and archeological resources including Natural Bridges National Monument, Monument Valley, Four Corners, Glen Canyon National Recreational Area, Cedar Mesa, San Juan River, Goosenecks State Park, and Canyonlands National Park. Additionally, Blanding is located about 1 hour from Moab and Arches National Parks.

The economy of Blanding is based on mineral processing, mining, livestock and agriculture, local commerce, tourism, and transportation. A boom in uranium and oil activity in the 1950s was a source of revenue for the construction of new roads and provided the economic climate necessary for the expansion of service industries and an associated population increase. Since the 1980s, the economy of Blanding has come to rely more on tourism activity, as a gateway community (City of Blanding 2011). However, like Kanab, the fiscal effects of the recession have been quite pronounced in the City of Blanding and the City of Kanab, with a 20% decline in sales-related tax revenue since 2008 (see Section 3.17).

Demographics

Population data were obtained from the Census Bureau, ADOC, and the State of Utah Governor’s Office of Planning and Budget. Table 3.16-1 summarizes historical and projected populations within the study area.

Table 3.16-1. Historical and Projected Population within the Study Area

Location	Population 1990*	Population 2000[†]	Population 2008[‡]	Population 2010[xx]	Total Change in Population (%) 1990–2000	Total Change in Population (%) 2000–2010	Total Change in Population (%) 1990–2010	Projected Population 2020[‡]	Projected Population 2030[‡]	Projected Population 2040[‡]
U.S.	248,709,873	281,421,906	304,059,724	308,745,538	13.2%	9.7%	24.1%	335,805[§]	363,584[§]	391,946[§]
Arizona	3,665,228	5,130,632	6,500,180	6,392,017	40.0%	24.6%	74.4%	8,779,567	10,347,543	11,693,553
Coconino County	96,591	116,320	128,558	134,421	20.4%	15.6%	39.2%	159,345	173,829	186,871
Bitter Springs CDP**	NR	547	1,059	452	NR	-17.4%	NR	1,600	1,954	2,273
Fredonia	1,207	1,036	1,145	1,314	-14.2%	26.8%	8.9%	1,260	1,335	1,403
Havasupai Indian Reservation	NR	503	NR	465	NR	-7.6%	NR	NP	NP	NP
Hopi Reservation	NR	1,134	NR	7,185	NR	533.6%	NR	NP	NP	NP
Navajo Nation[¶]	NR	23,216	NR	173,667	NR	648.0%	NR	NP	NP	NP
Page	6,598	6,809	7,253	7,247	3.2%	6.4%	9.8%	7,720	8,027	8,303
Tusayan CDP**	NP	562	616	558	NR	-0.7%	NR	673	711	745
Mohave County	93,497	155,032	196,281	200,186	65.8%	29.1%	114.1%	281,668	330,581	367,952
Kaibab Band of Paiutes	NR	212	218	240	NR	13.2%	NR	261	276	289
Kaibab CDP**	NR	275	NR	124	NR	-54.9%	NR	NP	NP	NP
Hualapai Tribe	1,532	1,353	1,836	1,335	-11.7%	-1.3%	-12.9%	2,503	2,948	3,289
Colorado City	2,426	3,334	4,540	4,821	37.4%	44.6%	98.7%	6,196	7,302	8,147
Utah	1,722,850	2,233,169	2,736,424	2,763,885	29.6%	23.8%	60.4%	3,652,547	4,387,831	5,171,391
Kane County	5,169	6,046	6,577	7,125	17.0%	17.8%	37.8%	8,746	10,394	12,034
Kanab	3,289	3,564	NR	4,312	8.4%	21.0%	31.1%	5,216	6,198	7,177
San Juan County	12,621	14,413	15,055	14,746	14.2%	2.3%	16.8%	15,319	16,653	18,051
Blanding	3,162	3,162	NR	3,375	0.0%	6.7%	6.7%	3,314	3,604	3,908
Washington County	48,560	90,354	137,589	138,115	86.1%	52.9%	184.4%	279,864	415,510	559,670
Garfield County	3,980	4,735	5,044	5,172	19.0%	9.2%	29.9%	5,843	6,823	7,656

Notes: NP = no projection available at this geographic level; NR = not reported.
* Source: Census Bureau (1990).
[†] Source: Census Bureau (2000).
[‡] Sources: ADOC (2009e); Governor's Office of Planning and Budget (2010).
[xx] Source: Census Bureau (2010).
[§] U.S. projected population written in thousands.
[¶] Navajo Nation Chapters within the study area were combined for the total Navajo Nation population in Coconino County.
**CDP = Census Designated Place

ARIZONA

Arizona experienced dramatic population growth between 1990 and 2010, with a 74.4% increase in residents, compared to 24.1% for the nation during the same time period. Future projections suggest that this growth is not over with for the state, with a 61.9% growth predicted between 2010 and 2030 (see Table 3.16-1). Coconino and Mohave counties are no exception; these counties have also experienced substantial growth for the past 20 years. Between 1990 and 2010, population increased 39.2% in Coconino County and 114.10% in Mohave County (see Table 3.16-1). As with the state, further growth is expected; between 2010 and 2030, growth in these counties is projected to increase 29.3% and 65.1%, respectively (see Table 3.16-1). Mohave County has experienced the most significant growth between 1990 and 2010 (114.1%), and is expected to see the most growth over the next 20 years (65.1%) (see Table 3.16-1). Much of the recent growth in Mohave County can be attributed to increased tourism activity (Mohave County 2008).

Within Coconino County, population in the Bitter Springs CDP grew 93.6% between 2000 and 2008, with population expected to continue to grow another 332% between 2010 and 2030. Fredonia has actually experienced negative population growth, with the number of residents decreasing 14.2% from 1,207 in 1990 to 1,036 in 2000. Both Page and the Tusayan CDP have experienced modest growth for the past 20 years, with population increasing 6.50% in Page and 9.60% in the Tusayan CDP between 2000 and 2008 (see Table 3.16-1). Fredonia experienced a decline in population between 1990 and 2000; however, population increased 26.8% between 2000 and 2010. Additionally, population is expected to increase another 1.6% in Fredonia over the next 20 years (see Table 3.16-1).

Within Mohave County, Colorado City experienced increases in total population of 98.7% between 1990 and 2010. Population in the Kaibab CDP dropped from 275 in 2000 to 124 in 2010, a 54.9% decline. However, overall, population forecasts for the County continue to show an upward trend increasing population from 6,916 in 2020 to 8,147 in 2040 (see Table 3.16-1).

UTAH

From 1990 to 2000, Utah's population increased by 29.6%, with a similar increase of 23.8% between 2000 and 2010; growth is expected to continue through 2030. Predicted population growth for Utah is consistent with Arizona projections, with population expected to increase 58.76% between 2010 and 2030 (see Table 3.16-1).

Population growth between 2000 and 2010 for the four counties in the study area has ranged from 2.31% for San Juan County up to 52.86% for Washington County. Kane and Garfield counties have experienced modest growth for the same time period (17.85% and 9.23%, respectively). Each county is predicted to experience some level of growth over the next 20–30 years, however population in Washington County is expected to continue to increase at a staggering rate of 200.84% between 2010 and 2030 (see Table 3.16-1). This remarkable growth for Washington County is attributed to factors such as a moderate climate, rich natural resources in the region, in-migration, aging Baby Boomers, and access to road and air transportation (Washington County 2009). In Kane County, the population of Kanab increased 8.40% between 1990 and 2000. Like the rest of the study area, population in Kanab is expected to continue to increase, with growth expected to reach 101.37% between 2000 and 2040. Very little demographic data is available for Blanding in San Juan, Utah. The population of Blanding was 3,162 in 1990. Population projections by the Governor's Office of Planning and Budget (2010) indicate that Blanding will see some growth through 2040, but will remain relatively modest with a 17.92% increase between 2020 and 2040 (see Table 3.16-1).

Stakeholder Values

In general, there are two basic perspectives on mineral exploration and development on the Arizona Strip and the Kaibab National Forest: people who support continued mineral exploration and development, and people who would prefer that mineral exploration and development not continue. Many different stakeholders have expressed an interest in the proposed mineral withdrawal because they support the withdrawal, or do not, or they fall somewhere along a spectrum between the two perspectives. Also, there are varying perspectives within different groups; for instance, some American Indians value the mineral exploration and development for the economic benefits (i.e., employment; see Mineral Activity Support discussion below), while other tribal members are influenced by negative experiences associated with uranium mining in the past (see “Withdrawal Support” discussion below). In summary, there are varying interests between individuals and groups who support mineral exploration and development and those who support withdrawal.

Stakeholders include American Indian tribes, local governments, area communities, mining companies, recreationists, and environmental and preservation groups, to name a few.

In many people’s minds, the proposed withdrawal area cannot be separated from the Grand Canyon itself. In fact, people often have such a strong sense of place attached to the Grand Canyon, even if they have never visited it, that potential changes to land management on the Arizona Strip and Kaibab National Forest could have important impacts to people’s quality of life related to the Grand Canyon. The Grand Canyon, along with the Kaibab National Forest and the BLM lands that form the withdrawal parcels, serve as important places of recreation for a variety of stakeholders. The Grand Canyon is a cultural and natural icon for Americans; however, not everyone goes to the Grand Canyon to “see” the same canyon.

Because the Grand Canyon and the surrounding area represent a unique place in the Southwest landscape, people’s values, beliefs, and attitudes are shaped by each individual’s “sense of place” of the area. A variety of factors will influence how people view the Grand Canyon, resulting in differing perspectives, whether the individual is a local resident, or national or international visitor. For this proposed withdrawal, more than 80,000 scoping comments from nearly every state in the United States and from more than 90 countries were submitted; this high level of national and international interest illustrates the importance of the Grand Canyon to people within Arizona, as well as across the United States and internationally.

Alternatively, many local residents (such as those who live in Kane and Washington counties, Utah) do not necessarily associate the proposed withdrawal parcels with the Grand Canyon. Many families have lived in the area for several generations and have strong connections to the land for earning a living and traditional and subsistence uses. Many residents of the communities surrounding the North Parcel are descendents of the Mormon pioneers who settled the area in the 1860s. These people still have strong connections to the land. Access to public land and resources, whether for earning a living, traditional and subsistence uses such as personal woodcutting, or for recreating, is very important to the local people.

Clearly, many people, especially local residents, may be linked to public lands in multiple and overlapping ways. The nature of people’s linkages strongly influences their values and attitudes toward public lands, and their social and cultural relationships to the land and to other people. These relationships are much more nuanced than any numbers in a social and economic profile can convey. They involve sentiments and emotions, attachments to specific special places, and beliefs and traditions developed through contact with public lands.

The following discussion presents some general ideas on how perspectives are developed and what they are related to, although there are likely to be any number of reasons people support the withdrawal or oppose it, or some variation in between. This discussion is not intended to be exhaustive but rather to present an overview of potential stakeholder values related to the proposed withdrawal.

MINERAL ACTIVITY SUPPORT

Many people, area communities, and local governments would benefit economically from continued or increased mineral exploration and development within the proposed withdrawal area. Mineral exploration and development can provide jobs, increase labor income, and provide tax revenue to local communities and the state, either directly from mining-related jobs, or indirectly from related businesses, construction purchases, etc.

States such as Arizona and Utah benefit from the proximity of a vast array of federal lands by providing economic benefits ranging from recreation opportunities to mineral exploration and development. State and local governments have long viewed these federal lands as being detrimental to the economic health of their communities because of lost property tax revenues; thus, mineral exploration and development and the benefits of this activity can offset lost property tax revenue.

Mineral development also creates new roads, which many recreationists support as these roads open access to area lands that have been previously inaccessible to vehicles. Recreationists enjoy increased access for sight-seeing, leisurely driving, OHV use, etc.

WITHDRAWAL SUPPORT

Regardless of current changes in mining technology, many people do not embrace mineral exploration and development because they are concerned that continued or increasing mineral exploration and development could impact their quality of life since they benefit economically, scientifically, spiritually, or emotionally, or otherwise from area lands being preserved.

Many people would like to see the proposed withdrawal lands removed from mineral exploration and development because they prefer the solitude they can experience, to see the area landscape and views preserved, the scientific value of the area to be preserved, etc. Each person with some attachment to the proposed withdrawal area has a different reason for their opinions and feelings regarding area lands and mineral exploration and development on these lands.

Some recreationists enjoy the remote and relatively undeveloped character of the area and seek out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region. These types of recreationists, unlike those discussed under Mineral Activity Support above, likely prefer that there is less access to area lands, less transformation of the landscape, etc.

Some stakeholders do not directly recreate or have an attachment to the Grand Canyon or region but are concerned about impacts to water quality if mining continues or increases. Irrespective of potential human health effects, continued or increased mining could affect consumer confidence, or perception, about the safety and reliability of municipal drinking water derived from the Colorado River. For American Indians, in particular, past experiences with health problems from working in mines, radiation contamination from dust and debris, the processing of ore on the reservations, and the spillage of radioactive materials into water systems have all affected how people view uranium mining. For example, the Navajo have been deeply affected by the mining of uranium on Navajo Nation lands and land bordering the Navajo Nation. From the 1940s through the 1970s, several uranium mines were set up on Navajo lands (Brugge and Goble 2002). These mines were welcomed as sources of employment for men in an area with very little employment. However, Navajo and non-Navajo miners worked in unsafe conditions with no protective gear against contamination and were not informed about the danger of radiation. Many Navajo miners later developed lung cancer or other ailments. Although these Navajo miners did not all smoke, they were working in unsafe conditions without adequate inhalation protection and thus were exposed to radon and the associated health risks, more so than they would be under current mining practices. Families of miners were affected through contaminated clothing or water (Johansen 1997). Other incidents also directly affected the Navajo; in 1979, a dam near Church Rock, New Mexico, that contained tailings and radioactive water burst and spilled 1,100 tons of tailings and millions of gallons of radioactive water in the Rio Puerco (Johansen 1997). The spill contaminated the drinking water for Navajos and their livestock, and clean-up efforts and public notification were inadequate. These types of experiences and the long-term environmental and health effects influence how all uranium mining is viewed by American Indians, regardless of the technology used or current best management practices (BMPs) for mining. The Navajo Nation has indicated that they will not approve any uranium mining or processing within its boundaries (Shirley 2008).

American Indian groups, such as the Havasupai, Hualapai, Hopi, Navajo, Zuni, and Southern Paiute, view the Grand Canyon, Arizona Strip, and Kaibab National Forest as integral to their culture. American Indians in the region descend from these six tribes and have long inhabited the region. Many of these groups see the area as part of their homeland. The Grand Canyon itself serves as a focal point for many of these homelands and in some cases as the actual point of origin for a people. American Indians feel a deep connection to their homeland. The land is a physical manifestation of their history and is alive; therefore, most American Indians feel that the Grand Canyon and the surrounding areas are sacred land. A detailed discussion of American Indian perspectives on the Grand Canyon can be found in Section 3.12 of this EIS.

Public Health and Safety

Public health aspects of uranium mining for this EIS are considered in terms of potential effects that would result at mines (from natural uranium ore); potential health effects at the mills or other off-site processing centers (from concentrated [enriched, or yellowcake] or depleted uranium [which is a byproduct of enrichment, not mining]) are not considered here. However, much of the following discussion does include a review of the health impacts of depleted uranium because of the paucity of studies of the effects of natural uranium on humans. This is not to imply that miners would be exposed to depleted uranium, but rather because more is known about the health effects from exposure to depleted uranium, it is used here to fill in the gaps of knowledge related to potential health impacts. In fact, natural uranium is more radioactive and may cause more health effects than depleted uranium.

Uranium is a naturally occurring element that is also radioactive; its toxicity to humans varies according to its chemical form and route of exposure. Generally, exposure to uranium can be harmful in some manner via inhalation, ingestion, or skin exposure. It is important to note that nationwide, people are exposed to an average of about 300 millirems per year (mrem/yr) of natural background radiation (National Council on Radiation Protection and Measurements 1987). Table 3.16-2 presents a summary of natural background radiation doses reported by the U.S. Department of Energy (2007) for the nation and the Blanding area.

Table 3.16-2. U.S. and Blanding Area Natural Background Radiation Doses

Radiation Source	U.S. Average Natural Background Radiation Dose (mrem/yr)	Blanding Area Natural Background Radiation Dose (mrem/yr)
Cosmic and cosmogenic radioactivity	28	68
Terrestrial radioactivity	28	74
Internal radioactivity	40	40
Inhaled radioactivity	200	260
Total	**300**	**440**

Source: U.S. Department of Energy (2007).

HEALTH RISKS

All mine operations are required to comply with stringent safety and health standards administered by the MSHA through federal regulations at 30 CFR Parts 1 through 199 and, in particular, Part 57. MSHA regulations include requirements for ground support systems, mine ventilation, electrical systems, combustible fluid storage, underground shops, equipment specifications and maintenance, explosives storage and handling, dust control, monitoring and reporting requirements, alarm systems, worker personal safety equipment, and restrictions for public access. To comply with MSHA standards, all mineral exploration and development would require the necessary MSHA mine permits and an MSHA-approved miner training plan, escape and evacuation plan, and ventilation plan.

Mine employees are typically trained in basic rescue and first aid techniques. Additionally, MSHA [30 CFR Part 49], includes requirements for the availability of on-site rescue teams, or access to off-site rescue teams. Per 30 CFR 49, each mine rescue team is required to be fully qualified, trained, and equipped for providing emergency mine rescue service. Additionally, each mine is required to develop a mine rescue notification plan outlining the procedures to follow in notifying the mine rescue teams when rescue is needed. Mine operators in the area can enter into agreements with air rescue services (typically via helicopter) to augment their emergency response capabilities, or provide response capabilities for accidents that occur on the surface, or during hauling.

The discussion of potential health risks associated with uranium mining that follows is based primarily on a 1999 report on the chemistry and toxicological effects of natural and depleted uranium (Craft et al. 2004), a report from the Agency for Toxic Substances and Disease Registry (1999), and from Technical Fact Sheets on Radionuclides (Argonne National Laboratory 2005; EPA 2000, 2010m).

Cancer

Radioactive material (thus, uranium) can be a cause of cancer. Scientists have never detected harmful radiation effects from low levels of natural uranium, although some harmful effects may be possible. Exposure to uranium can be harmful and carcinogenic under any one of three conditions: inhalation of, ingestion of, or skin exposure to uranium. Inhalation exposure to uranium can cause potentially harmful health effects from both chemical and radioactive exposure, especially if the exposure is over a long period. Potentially harmful health effects from ingested or skin exposure to natural and depleted uranium appear to be solely chemical in nature, not radiological. Inhalation, ingestion or skin exposure to uranium could result from exposure at the mines on site, as well as exposing miner’s families to uranium if material is carried home on worker’s skin, hair, or clothing. The practice of not wearing protective clothing or taking unwashed clothing home was more common prior to creation of MSHA in the 1970s. Each mine imposes safety mechanisms designed to reduce on-site and off-site exposure, such as wearing protective clothing and gear, and removing this clothing or gear before leaving the mine site, taking a shower, etc. Additionally, per MSHA [30 CFR 75.1712], operators are required to provide adequate facilities for miners to change from the clothes worn underground, to provide for the storing of such clothes from shift to shift, and to provide sanitary and bathing facilities.

Natural and/or depleted uranium are only weakly radioactive and are not likely to cause cancer from radiation; no human cancer has been documented as a result of exposure to natural or depleted uranium (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010). Depleted uranium is a byproduct of uranium enrichment and processing. A paper by Miller et al. (2002) did demonstrate that depleted uranium at relatively high levels could cause cellular transformation. However, Miller et al. (2002) used a human osteoblast immortalized cell line to study the effects of uranium and found that the cells were transformed and did have DNA damage. However, cellular transformation, while indicative of the ability of a compound to alter cells and damage DNA, is only part of identifying a carcinogen. Further studies need to be conducted in humans to determine to what degree uranium causes increases in osteosarcomas.

However, uranium can decay into other radionuclides, which can cause cancer if the exposure is great enough and for a long enough period. Doctors who studied lung and other cancers in uranium miners did not find a link to uranium radiation's being the cause of these cancers. The miners smoked cigarettes and were exposed to other substances that are known to cause cancer, and the observed lung cancers were attributed to large exposures to radon and its radioactive transformation products (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Ionizing Radiation

Ionizing radiation is derived from radioactive materials and is a result of the radioactive decay of uranium. Research conducted through Biological Effects of Ionizing Radiation (BEIR) Series VII (BEIR 2006), indicates that risk of developing cancer is related to the dose of the radiation and that any dose would increase this risk. In other words, the dose does not have to reach a specific level before it can cause increased risk—just increasing exposure increases the risk. Similarly, reports from the World Health Organization (2010) state that lung tissue damage is possible after inhalation of uranium, leading to a risk of lung cancer that increases with increasing radiation dose.

However, it is important to note that while risk increases, because depleted uranium is only weakly radioactive, very large amounts of dust (on the order of grams) would have to be inhaled for the additional risk of lung cancer to be detectable in an exposed group.

BEIR (2006:267) states, "Risk may depend on the type of cancer, the magnitude of the dose, the quality of the radiation, the dose-rate, the age and sex of the person exposed, exposure to other carcinogens such as tobacco, and other characteristics of the exposed individual. Despite the abundance of epidemiologic and experimental data on the health effects of exposure to radiation, data are not adequate to quantify these dependencies precisely." BEIR (2006) developed their risk model based on types and levels of radiation different from that seen with uranium, making it difficult to extrapolate their results to a prediction of radiation effects from uranium.

"Because of the extreme difficulty of assessing dose and effects of internally ingested uranium, it is therefore necessary to use available animal and human data to establish exposure limits. Based on those studies, the evidence suggests that exposure to natural uranium is unlikely to be a significant health risk in the population and may well have no measurable effect" (Lantz 2010:3).

Kidney Disease

Scientists have seen chemical effects from uranium exposure; in fact, kidney disease is the most prominent adverse health outcome. People have developed signs of kidney disease after intake of large amounts of uranium (for example, Gulf War veterans with embedded uranium shrapnel).

Animals have also developed kidney disease after they have been exposed to large amounts of uranium. The following discussion of kidney damage in animals is included to illustrate potential impacts on humans; the effects discussed below have been observed in animals and can also occur in humans if the uranium dose is high enough. See Sections 3.7 and 3.8 for a full discussion of potential health impacts to fish and wildlife and special status species.

In animals, kidney damage is the principal toxic effect of uranium, especially to its soluble compounds (Craft et al. 2004; Lantz 2010). The kidneys have been identified as the most sensitive target of uranium poisoning, consistent with the metallotoxic action of a heavy metal. The effects of uranium exposure seem to be primarily at the cellular level. The toxic response of the kidney is caused by the accumulation of uranium in cells lining the kidney (renal tubular epithelium), which results in premature cellular death and atrophy in the kidneys' tubular wall. The major functions of the cells lining the kidney include reabsorbing water and small molecules from the filtrate into the blood and secreting wastes from the blood into the urine. If the cells in the lining are prematurely dying or atrophying, the result is decreased reabsorption efficiency; this effect has been found in humans and animals. Heavy metal ions, such as uranyl ions (an oxidized state of uranium), are also effective in delaying or blocking the cell division process, thereby magnifying the effects of cell death. As noted, above, these effects on the kidney have been observed in animals and can also occur in humans if the uranium dose is high enough. However, these effects have only been seen in certain severe poisoning incidents in humans (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Lung Toxicity

Human and animal studies have shown that long-term retention in the lungs of large quantities of inhaled insoluble uranium particles (e.g., carnotite dust [4% uranium as uranium dioxide and triuranium octaoxide, 80%–90% quartz, and <10% feldspar]) can lead to serious respiratory effects. However, animals exposed to high doses of purified uranium (as uranyl nitrate hexahydrate, uranium tetrachloride, uranium dioxide, uranium trioxide, uranium tetraoxide, uranium fluoride, or uranium acetate) through the inhalation or oral route failed to develop these respiratory ailments. The lack of significant pulmonary injury in animal studies with insoluble compounds indicates that other factors, such as diverse inorganic particle abrasion or chemical reactions, may contribute to these effects (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Respiratory diseases have been associated with human exposure to the atmosphere in uranium mines. Respiratory diseases in uranium miners (fatal in some cases) have been linked to exposure to silica dust, oxide dusts, diesel fumes, and radon and associated radon decay products (also known as "radon daughters" or "radon progeny"), in conjunction with cigarette smoking. In several of these studies, the investigators concluded that, although uranium mining clearly elevates the risk for respiratory disease, uranium contributes minimally, if at all, to this risk. The mine air also contained radon and its daughters and cigarette smoke, which are proven carcinogens. As in human studies, several animal studies in which uranium-containing dusts, such as carnotite uranium dust, were used reported the occurrence of respiratory diseases (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Other Toxicities

It is not known whether exposure to uranium causes reproductive effects in people. Very high doses of uranium have caused reproductive problems (reduced sperm counts) in some experiments with laboratory animals; however, most studies show no effects. Further, it is not known whether exposure to uranium has effects on the development of the human fetus. Very high doses of uranium in drinking water can affect the development of the fetus in laboratory animals. One study reported birth defects, and another reported an increase in fetal deaths (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Radon

Radon is considered a Class A carcinogen, which indicates that it is known to cause cancer in humans. Radon is the leading cause of lung cancer among non-smokers and the second leading cause of lung cancer overall. An estimated 21,000 deaths per year are attributed to radon gas exposure; 13% of those deaths are among people who never smoked (EPA 2010n).

Inhalation of radon and radon decay products (RDPs) is the method of exposure known to increase the risk of lung cancer. When the radon is exhaled, some of the RDPs are trapped in the lungs. As the trapped RDPs undergo radioactive decay and emit alpha energy, the particles can strike sensitive lung tissue, causing chemical and/or physical damage to the DNA. It is important to note that not everyone who breathes radon gas will develop lung cancer. Risk of developing lung cancer associated with radon exposure also includes 1) how much radon is in the indoor environment; 2) the amount of time spent in that indoor environment; and 3) whether the person smokes or has ever smoked.

The only known health effect of radon is an increased risk of lung cancer, and exposure to elevated radon levels does not result in any warning symptoms like headaches, nausea, fatigue, or skin rashes. The only way to know whether a person is being exposed to elevated radon levels is to test the indoor environment (National Research Council’s Commission on Life Sciences 1999).

Ingestion of Wildlife Exposed to Uranium

As discussed in Sections 3.6 through 3.8 on vegetation, fish and wildlife, and special status species biota can be exposed to chemical and radiation hazards through various pathways, including ingestion (soil, food, and water), inhalation, and various cell absorption processes. The potential linkage between chemical and radiation hazards associated with mining operations and biota are considered in those sections. The potential linkage between human ingestion of contaminated vegetation, fish, and wildlife exposed to uranium and uranium decay series (radon and its progeny) is discussed below.

As with human exposure to uranium discussed above, wildlife can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer (see Sections 3.6–3.8 and 4.6–4.8).

Human consumption of contaminated vegetation and wildlife could result in human health risks; however, the transfer of uranium from the plants and animals to humans through ingestion has not been systematically studied.

Radon is not known to bioaccumulate in plants or animals; however, no systematic study has been completed.

HUMAN SAFETY RISKS

As previously noted, there are also potential safety risks associated with the mining operations themselves. In general, public safety risks are mitigated by proposed safety mechanisms mandated by the land managing agencies such as BLM and Forest Service, as well as MSHA. In general, mine operations are secured with locking gates to prevent public access and are reclaimed to a standard to ensure that ground surface integrity is not compromised.

Transportation Conflicts

The potential transportation conflicts associated with mine traffic include traffic accidents with other vehicles. As discussed in Section 3.15 (Recreation Resources; see Table 3.15-1), there is a total of 89.71 miles of paved roads and 3,360.91 miles of unpaved roads in the proposed withdrawal area. Recreation sites and visitation data are also discussed in Section 3.15 (Recreation Resources; see Table 3.15-2); visitation for recreation sites considered in this study (see Section 3.15), for which there are data, totaled 4.43 million visitors in 2009. Recreation sites were identified when located within a proposed withdrawal parcel, or when access through a proposed withdrawal parcel is required (see Table 3.15-2). Thus, an estimated 4.43 million visitors are using a network of 3,450.62 miles of paved and unpaved roads to access area recreation sites.

For existing and future mine sites in the proposed withdrawal area, no processing facilities would be located at the mine sites and all ore would be hauled off-site. Because of the decentralized nature of breccia pipe deposits, ore would be hauled by truck. All of the routes described below are heavily traveled by local, national, and international tourists visiting the region. Specific mine locations are unknown, and therefore the specific routes of haul traffic are unknown. Both the BLM and Forest Service require a detailed plan of operation for proposed mine development projects, which would include a transportation plan. Regardless of the parcel being mined, all haul routes are assumed to traverse some portion of Navajo Nation land; and all of the haul routes for potential mines located west of Kanab Creek pass through the Kaibab Reservation. The Navajo Nation does not support ore transportation through reservation land. Through development of future mine-specific plans of operation, BLM and the Forest Service would consult with ADOT or UDOT to determine road condition/road suitability, weight limits, and other factors to be considered in identifying specific haul routes.

Potential access routes for haul traffic from the North Parcel include use of SR 98, SR 389, U.S. 89A, U.S. 89, U.S. 160, U.S. 191, and SR 163 passing through Fredonia, Page, Kaibito, and Kayenta, Arizona, and Kanab, Mexican Hat, and Bluff, Utah, terminating in Blanding, Utah.

Potential access routes for haul traffic from the East Parcel include use of U.S. 89A, U.S. 89, U.S. 160, U.S. 191, and U.S. 163 passing through Marble Canyon, Page, Kaibito, and Kayenta, Arizona, and Mexican Hat, and Bluff, Utah, terminating in Blanding, Utah. Although UDOT has indicated they encourage truck traffic not to use U.S. 163 between Kayenta and Bluff, Utah (Rick Bailey, personal communication, 2011), there is no known regulatory requirement to avoid, or explicitly not use this highway, therefore it is analyzed as a potential haul route.

Potential access routes for haul traffic from the South Parcel are divided between the east and west halves of the parcel. Haul traffic from the west half of the South Parcel use SR 64, U.S. 89, U.S. 160, U.S. 191, and SR 163 through Cameron, Tuba City, Tonalea, Cow Springs, and Kayenta, Arizona, and Bluff, Utah. Haul traffic from the east half of the South Parcel use SR 64, I-40, U.S. 89, U.S. 160, U.S. 191, and SR 163 through Tusayan, Red Lake, Williams, Parks, Bellemont, Flagstaff, Gray Mountain, Cameron, Tuba City, Tonalea, Cow Springs, and Kayenta, Arizona, and Bluff, Utah.

Average Annual Daily Traffic (AADT) counts were compiled, using ADOT traffic data (ADOT 2009b) and Utah Department of Transportation traffic data (Utah Department of Transportation 2009) for each of the transportation routes with potential to be used for ore hauling. AADT is typically measured at points within designated segments of a roadway indicated by mileposts. For the purposes of comparing current traffic conditions to proposed traffic conditions, a maximum/minimum AADT range was established for the aggregated traffic counts along each of the roadways likely to be used by ore haul trucks. Generally, AADT counts indicated that I-40, U.S. 89, and U.S. 89A are the most traveled roads, while SR 398 is generally the least traveled road (Appendix K).

Currently, ore trucks cannot exceed 25 mph on unpaved roads.

Haul Route Radiation Exposure

Ore is transported by haul trucks from the mine to the mill; the haul trucks and ore are covered to prevent the release of fugitive dust from the ore, as it is transported. There is no regulatory requirement for radiation monitoring along haul routes, however many mining companies voluntarily conduct gamma monitoring (gamma rays are emitted by uranium as it decays and forms its radioactive progeny). The dose of radiation an individual is exposed to is directly proportional to the amount of time spent in a radiation field and the distance from the radiation.

Based on a U.S. Department of Energy (2007) study, Table 3.16-3 illustrates potential radiological dose exposure from routine transportation of uranium ore. The U.S. Department of Energy study calculated that after 10 years of 120–150 haul trucks of ore pass per day, a nearby resident (within 33 feet of a haul route) would have an increased life time probability of developing cancer. The probability would increase from the national average of 220,000 in one million to 220,001 in one million.

Table 3.16-3. Individual Exposure from Uranium-related Hauling

Exposure scenario	Estimate dose
Traffic jam	0.026 mrem
Passing vehicle	7.4×10^{-6}
Vehicle intersection	1.5×10^{-5}
Nearby resident	0.22 mrem/year

Source: U.S. Department of Energy (2007).

Denison Mines Corporation provided gamma monitoring results to the ADEQ, for the Arizona 1 haul route (from the Arizona 1 Mine to the White Mesa Mill) (Woodward 2011). The monitoring data spanned January 2008 to July 2010; hauling for Arizona 1 began in late 2009, thus data provided shows pre-hauling and during hauling millirems per hour, day and week. Based on data from 10 monitors, gamma exposure prior to any hauling activities ranged from 1.95–3.63 mrem/week in 2008. From late 2009 to mid 2010, gamma exposure during hauling ranged from 2.17 mrem/week to 3.63 mrem/week; there was a spike at one of the monitors from March to July 2010, where mrem/week reached 6.18, measured over a 3 month period.

As discussed previously (see Table 3.16-2), nationwide, people are exposed to an average of about 300 mrem/year of natural background radiation (National Council on Radiation Protection and Measurements 1987). Therefore, these gamma exposure rates are consistent with exposure to natural background radiation.

Haul Route Accident Procedures

The potential frequency of haul truck accidents is discussed above. In terms of accident clean-up, uranium ore is regulated as a Class 7 radioactive material under the hazardous materials regulations in 49 CFR 172. Uranium ores and concentrates of uranium ore are classified as Low Specific Activity Group – 1 material. Because of their low specific activity, ore shipments are generally exempt from most of the packaging and labeling requirements of other Class 7 radioactive materials.

Mine operators typically hire a transportation contractor to handle all ore hauling and shipping. The transportation contractor would be responsible for preparing and implementing an emergency response plan, per Title 49 CFR 172, Subpart G. The plan would address response protocol in the event of an accident that results in the spillage of uranium ore on public roads, including traffic control, clean-up procedures, clean-up verification, and decontamination of equipment and tools.

Typical cleanup procedures would depend on the size of the spill; however, in general spilled ore can be cleaned up with a loader, hand shovels, rakes, and shop brooms (Energy Fuels Resources 2008). If the spill is larger, ore can be transferred to another truck approved for hauling uranium ore. Post clean-up, a gamma meter can be used to identify residual radiation spots on surfaces. Recovered materials are typically transported to the mill. In Washington State in 2005, the clean-up of 12 ore debris sites attributed to uranium ore spillage from haul trucks, included excavating the ore debris, transporting and placing the excavated material in a repository at the mine, performing radiological surveys to confirm the removal of the ore debris, and backfilling and/or regrading of the excavations (MFG, Inc. 2005).

Environmental Justice

The EPA's Office of Environmental Justice defines environmental justice as

> the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group[s] should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.

Meaningful involvement means that 1) community residents in the potential impact area have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; 2) the public's contribution can influence the regulatory agency's decision; 3) the concerns of all participants involved will be considered in the decision-making process; and 4) the decision-makers seek out and facilitate the involvement of those in the potential impact area (EPA 2003b). Environmental justice is achieved when everyone, regardless of race, culture, or income, enjoys the same degree of protection from environmental and health hazards and has equal access to the decision-making process, in order to have a healthy environment in which to live, learn, and work (EPA 2003b).

EO 12898 (February 11, 1994) and its accompanying memorandum have the primary purpose of ensuring that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." To meet this goal, EO 12898 specified that each agency develop an agency-wide environmental justice strategy.

This environmental justice analysis follows the guidance and methodologies recommended in the federal CEQ's Environmental Justice Guidance under the National Environmental Policy Act (December 1997) (CEQ 1997).

DEFINING MINORITY AND/OR LOW-INCOME POPULATION

Minority Communities

Minority or low-income communities that may be addressed in the scope of NEPA analysis are generally considered as follows:

1. Minority—Individual(s) classified by Office of Management and Budget Directive No. 15 as Black/African American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other non-white persons.
2. Minority Population—Minority populations should be identified where either:
    - the minority population of the affected area exceeds 50%; or
    - the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low-Income Population

Low-income populations in an affected area are populations below the annual, statistical poverty thresholds from the U.S. Census Bureau's current population reports on income and poverty. Families and persons are classified by the U.S. Census Bureau as "below poverty level" if their total family income or unrelated individual income is less than the poverty threshold specified for the applicable family size, age of householder, and number of related children under 18 that are present. A low-income population exists where either the low-income population of the affected area exceeds 50%; or the low-income population percentage of the affected area is meaningfully greater than the low-income population percentage in the general population or other appropriate unit of geographic analysis.

Disproportionately High and Adverse Human Health and Environmental Effects

Under Executive Order 12898, when determining whether human health effects are disproportionately high and adverse, agencies must consider the following three factors to the extent practicable:

- Whether the health effects, which may be measured in risks and rates, are significant, unacceptable, or above generally accepted norms (adverse health effects may include bodily impairment, infirmity, illness, or death).
- Whether the risk or rate of hazard exposure by a minority population or low-income population to an environmental hazard is significant and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

Similarly, when determining whether environmental effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

- Whether there is or would be an impact to the natural or physical environment that significantly and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment;
- Whether environmental effects are significant and are or may have an adverse impact to minority populations, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and
- Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

MINORITY AND/OR LOW-INCOME POPULATIONS IN THE STUDY AREA

Minority Communities

Census data from 2010 are available for identifying minority populations. Based on the criteria presented above, there are five tribal communities in the study area in which the minority population exceeds 50%. These five communities are the Havasupai Indian Reservation, Hopi Reservation, Navajo Nation, Kaibab Band of Paiutes, and Hualapai Tribe (see Table 3.16-4). The Navajo Nation is directly adjacent to the East and South parcels. Additionally, as discussed in the Transportation Conflicts section, all potential haul routes pass through the Navajo Nation, and all of the haul routes for potential mines west of Kanab Creek pass through the Kaibab Reservation, en route to the mill in Blanding, Utah. The Kaibab Band of Paiutes is directly adjacent to the North Parcel, and the Havasupai are directly adjacent to the South Parcel.

Additionally, the populations of the Bitter Springs CDP and Kaibab CDP are 98.9% and 83.1% American Indian, respectively; it is important to note that the Bitter Springs CDP is located on the Navajo Nation and the Kaibab CDP is located on the Kaibab Reservation. San Juan County also includes a minority population of over 50.4%. Approximately 1.2 million acres of land within the Navajo Nation extends into San Juan County (San Juan County 2008).

Table 3.16-4. Data for Minority (2010 Census) and Low-Income (2000 Census) Populations in the Study Area

Location	Minority % of 2010 Population, Hispanic or Latino (More than 50%)	Minority % of 2010 Population, American Indian (More than 50%)	Poverty % of 2005–2009 Population, Living Below Poverty Level (Individuals) Meaningfully greater than general population	Poverty % of 2005–2009 Population, Living Below Poverty Level (Families) Meaningfully greater than general population
U.S.	16.3	0.9	13.5	9.9
Arizona	29.6	4.6	14.7	10.5
Coconino County	13.5	27.3	17.4	11.3
Bitter Springs CDP**	0.9	98.9	33.7	27.4
Fredonia	3.7	7.7	7.6	3.3
Havasupai Indian Reservation	4.3	93.8	48.6	30.1
Hopi Reservation	1.9	95.4	33.8	32.9
Navajo Nation¶	2.0	96.1	38.8	33.6
Page	7.3	34.0	13.3	10.9
Tusayan CDP**	40.7	8.1	11.5	0
Mohave County	14.8	2.2	15.5	10.7
Kaibab Band of Paiutes	5.4	84.6	55.5	52.1
Kaibab CDP	6.5	83.1	43.1	21.6
Hualapai Tribe	3.8	94.7	48.6	46.6
Colorado City	0.6	0.0	32.7	33.8
Utah	13.0	1.2	10.4	7.2
Kane County	3.7	1.5	10.6	8.0
Kanab	4.2	1.0	9.0	6.4
San Juan County	4.4	50.4	28.7	22.6
Blanding	3.8	29.4	23.8	14.4
Washington County	9.8	1.4	9.8	7.1
Garfield County	4.5	1.6	10.8	6.7

Source: American Community Survey data 2005–2009 (Census Bureau 2009, 2010)

**CDP = Census Designated Place

¶ Navajo Nation Chapters within the study area were combined for the total Navajo Nation population in Coconino County.

Low-Income Population

Only 2005–2009 American Community Survey census data are available for identifying low-income populations (Census Bureau 2009); the 2010 census has not released this level of detail yet. Of the communities in the study area (see Table 3.16-4), only the Kaibab Band of Paiutes (55.5%) has more than 50% of its population (individuals) living below the poverty level. Other communities with a high occurrence of individuals living below the poverty level, compared to the U.S. and state averages, include the Bitter Springs CDP (33.7%), Kaibab CDP (43.1%), Havasupai Indian Reservation (48.6%), Hopi Reservation (33.8%), Navajo Nation (38.8%), Hualapai Tribe (48.6%), Colorado City (32.7%), San Juan County, Utah (28.7%), and Blanding (23.8%).

Environmental Justice Communities

In summary, the following tribes, communities, and counties meet the criteria for identification as an "Environmental Justice community:" all five tribes in the study area, including the Havasupai, Hopi, Navajo, Kaibab and Hualapai; and the communities of Bitter Springs CDP, Kaibab CDP, Colorado City, Blanding, and San Juan County.

3.16.2 Social Condition Indicators

Mineral exploration and construction, operation, and maintenance of proposed uranium mine facilities and/or the proposed withdrawal of mineral estates and the associated reduction in mineral development have the potential to affect social conditions resources. Resource indicators include those conditions listed below and described in Section 3.16:

- Demographics;
- Stakeholder Values;
- Public Health and Safety; and
- Environmental Justice.

Demographics

Indicators of potential effects to demographics will be measured in terms of projected population and historical trends in growth. Changes in demographics can also be attributed to potential employment opportunities and will be analyzed concurrently with effects on employment.

Stakeholder Values

Indicators of potential effects on stakeholder values could be affected by changes in land management related to the proposed withdrawal parcels; impacts would result if local or non-local individuals' or community's values and beliefs are compromised. As discussed in Section 3.16, stakeholder values are assessed using two basic perspectives: mineral exploration and development support, or withdrawal support. Accordingly, impacts to stakeholder values are assessed qualitatively.

Public Health and Safety

Indicators of potential effects on public health and safety are described in terms of where known health risks from exposure to uranium and uranium decay products would occur. Risks include health effects resulting from inhalation of, ingestion of, or skin exposure to uranium; health issues can involve cancer, lung toxicity, and kidney disease. Effects will be measured by indicators that establish the likelihood that mineral exploration and development could result in human exposure to uranium ore and the likelihood that that exposure could manifest itself as health impacts.

Environmental Justice

Indicators of potential environmental justice conditions would be evaluated by assessing the presence, and percentage of, minority and/or low-income populations in the study area and the distribution of benefits versus anticipated effects.

The following resource condition indicators apply to social conditions in the study area (Table 3.16-5).

Table 3.16-5. Social Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Demographics	There could be changes in population levels associated with decreased mineral exploration and development under a proposed withdrawal. Likewise, the continued mineral development in the absence of a proposed withdrawal could involve local population increases as additional workers are required.	*Indicator:* The current and projected population for counties and communities in the study area.
Stakeholder Values	Stakeholder values may be affected by changes in land management related to the proposed withdrawal areas.	*Indicator:* Public comments during scoping indicating general support for the withdrawal or support for mineral exploration and development (and no withdrawal).
Public health effects	The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport.	*Indicator:* Estimated number of haul trips through local communities. *Indicator:* Potential exposure, public health risk, from single incident, effectiveness of cleanup, and total anticipated incidents.
Environmental justice	The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. Environmental justice is the equitable distribution of proposed withdrawal benefits and risks with respect to low-income or minority populations. In the case of uranium mining in the proposed withdrawal area, it is the distribution of the proposed withdrawal benefits, primarily economic, compared with the distribution of the proposed withdrawal impacts, such as pollution or risk of pollution that is the issue.	*Indicator:* Identification of populations considered low income and/or minority in the proposed withdrawal area that would either be adversely affected or benefit from the activity. *Indicator:* Distribution of proposed withdrawal risks or adverse effects on the above populations. *Indicator:* Distribution of proposed withdrawal benefits to the above populations. *Indicator:* Comparison of minority/low-income populations' risks and benefits with those for non-minority/non-low-income populations.

3.17 ECONOMIC CONDITIONS

Important general economic metrics for the study area include economic output and value-added; industry employment and earnings; unemployment rates; personal income; and taxes and revenues. This section also provides additional information regarding mining, tourism and recreation and environmental economics. The economic study area is generally rural, with two major urban centers (Flagstaff, Arizona, and St. George, Utah) within 75 miles of the proposed withdrawal area. Federal lands constitute the majority of the area and all five counties have a large land area with a dispersed population. The study area for economic conditions is the same as the study area described for social conditions (see Section 3.16).

The Grand Canyon is a substantial natural barrier which effectively divides the study area into two separate geographic and economic sub-areas. In order to effectively capture this distinction, the economic analysis describes economic conditions and the potential effects of the alternatives by sub-area: the area north of the Grand Canyon (North Study Area) and the area south of the Grand Canyon (South Study Area). All of the Utah counties (Garfield, Kane, San Juan and Washington) are located in the North Study Area, along with small portions of Coconino and Mohave counties of Arizona. The majority of the land area and population of Coconino and Mohave counties lie in the South Study Area.

Most economic data are only reported at the county level. Consequently, historical economic information provided for the North Study Area in this section does not include the portions of Coconino County and Mohave County that are located north of the Grand Canyon; economic data for those areas are included in historical data for the South Study Area. Using 2009 IMPLAN data files for individual zip codes, we are able to describe some economic metrics for the northern portions of Mohave County and Coconino County specific to that year and that information is provided in the discussion, where available.

3.17.1 Regional Economic Background

North Study Area

Southern Utah and Northern Arizona were settled in the mid-nineteenth century by members of the Church of Jesus Christ of Latter-day Saints. Initially, farming and ranching were the primary economic drivers of the settlements, along with some silver mining in Washington County and copper, gold and vanadium mining in San Juan County. In 1909 Mukuntuweap National Monument (later named Zion National Park) was established, marking the beginning of tourism as a significant sector in the local economy, particularly in the southwestern Utah counties (San Juan County 2011; Washington County 2011).

In recent years, portions of the North Study Area (particularly the City of St. George and nearby communities) have experienced substantial economic growth and development, while other areas have seen relatively little growth or new economic development. In the area closest to the North Parcel, the Town of Fredonia has struggled economically since losing the mining and timber related jobs that once supported its economic base. Today, the primary employment base in the town is the Forest Service regional center. Many of the remaining residents in Fredonia commute to work in Kanab, Utah (personal communication, Carl Taylor and Bill Towler, Coconino County 2011). Kane County has experienced similar economic struggles as natural resource extraction jobs diminished and were replaced by lower-paying hospitality jobs (personal communication, Matt Brown, Kane County Economic Development Director 2011). Although farther from the withdrawal area, San Juan County's economy is the most dependent on mineral and energy resources of the study area counties and it currently supports the nearest active uranium mill to the withdrawal areas.

South Study Area

The area south of the Grand Canyon had been sparsely settled in the nineteenth century but began to grow dramatically after the Atlantic & Pacific Railroad was established in 1883. Flagstaff soon became the population and economic hub of the area and was named the county seat when Coconino County was formed in 1891. Mohave County, which was initially populated by gold miners and Mormon settlers, also experienced growth as a result of the railroad. Early industries of both counties included farming, ranching, logging and stone quarrying. Tourism became a major economic driver with the establishment of Grand Canyon National Park in 1919. The area's tourism sector was further solidified with the construction of Route 66 and the dawn of American highway travel (ADOC 2009a).

Today, tourism continues to be the largest economic driver in Flagstaff and Coconino County. Northern Arizona University (NAU), regional services provided to a large trade area including the western portions of the Navajo Reservation, and a number of medium-sized manufacturing operations are other important components of the local economic base in Coconino County (personal communication, Carl Taylor and Bill Towler, Coconino County 2011). Mohave County also maintains a focus on recreation and tourism with 1,000 miles of shoreline (Lake Havasu, Lake Mohave and the Colorado River) and the longest stretch of historic U.S. Route 66 (ADOC 2009c).

3.17.2 Existing Conditions

Economic Activity

ECONOMIC OUTPUT AND GROSS REGIONAL PRODUCT

Economic output is a measure of the value of industry production over a given period of time and, for most sectors, reflects gross receipts. For example, in manufacturing, output is equal to sales plus/minus change in inventory; in service industries, output is equal to sales. Gross Regional Product (GRP) measures the overall size of the economy of a specified region and is defined as gross economic output minus intermediate inputs (purchases from other sectors). Each sector's contribution to GRP is called "value added." Thus the value added for each sector reflects that sector's economic output net of purchases of intermediate inputs.

North Study Area

The 2009 industry breakdown of output and value added for the North Study Area (including the northern portions of Coconino and Mohave counties) is shown in Table 3.17-1. In 2009, the sum of value added across all industries (the GRP for the North Study Area) was almost $4 billion.

Table 3.17-1. North Study Area Output and Value-Added (GRP) by Sector, 2009

Description	Output	Value Added (GRP)	Sector Share of GRP
Agriculture, Forestry, Fishing, and Hunting	$41,904,892	$12,442,475	0.3%
Mining	$215,065,598	$109,019,639	2.7%
Utilities	$110,160,498	$57,549,284	1.4%
Construction	$661,938,688	$270,174,963	6.8%
Manufacturing	$636,984,949	$171,910,934	4.3%
Wholesale Trades	$157,745,575	$99,839,367	2.5%
Retail Trades	$532,630,031	$449,342,345	11.3%
Transportation and Warehousing	$527,082,798	$268,199,803	6.7%
Information	$182,511,691	$84,681,527	2.1%
Finance and Insurance	$376,174,687	$157,310,315	3.9%
Real Estate and Rentals	$712,743,267	$500,593,963	12.5%
Professional, Scientific, and Technical Services	$247,586,895	$159,642,623	4.0%
Management of Companies	$14,599,524	$5,942,541	0.1%
Administrative and Waste Services	$149,047,098	$81,878,468	2.1%
Educational Services	$33,626,778	$15,696,788	0.4%
Health and Social Services	$789,247,975	$436,896,241	10.9%
Arts, Entertainment, and Recreation	$85,919,051	$48,243,035	1.2%
Accommodations and Food Services	$506,140,951	$256,458,548	6.4%

Table 3.17-1. North Study Area Output and Value-Added (GRP) by Sector, 2009 (Continued)

Description	Output	Value Added (GRP)	Sector Share of GRP
Other Services	$300,785,473	$176,654,961	4.4%
Government and non-NAICs	$693,976,178	$628,896,156	15.8%
Total Output and GRP	**$6,975,872,597**	**$3,991,373,976**	

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

The government sector contributed the most total value added to the North Study Area, accounting for 16% of GRP, followed by real estate (13% of GRP), retail (11% of GRP), and health and social services (10% of GRP).

South Study Area

Table 3.17-2 shows output and value added by sector for the South Study Area. Gross regional product for the South Study Area was approximately $8 billion in 2009. The top five sectors, in terms of value added were government (19% of GRP), real estate (15% of GRP), health and social services (12% of GRP), retail (11% of GRP), and manufacturing (10% of GRP).

Table 3.17-2. South Study Area Output and Value-Added (GRP) by Sector, 2009

Description	Output	Value Added (GRP)	Sector Share of GRP
Agriculture, Forestry, Fishing, and Hunting	$84,804,767	$26,729,780	0.3%
Mining	$137,781,971	$75,689,409	0.9%
Utilities	$201,072,956	$97,962,037	1.2%
Construction	$803,370,560	$346,517,359	4.2%
Manufacturing	$2,334,560,738	$824,651,720	10.1%
Wholesale Trades	$254,063,705	$163,893,473	2.0%
Retail trades	$1,070,262,931	$901,896,980	11.0%
Transportation and Warehousing	$489,478,086	$221,681,606	2.7%
Information	$246,281,029	$118,001,787	1.4%
Finance and Insurance	$478,533,665	$221,961,318	2.7%
Real Estate and Rentals	$1,739,290,641	$1,198,131,054	14.6%
Professional, Scientific, and Technical Services	$376,336,270	$238,955,633	2.9%
Management of Companies	$35,368,416	$17,717,177	0.2%
Administrative and Waste Services	$330,164,266	$192,975,791	2.4%
Educational Services	$52,238,598	$33,840,610	0.4%
Health and Social Services	$1,760,333,136	$1,005,244,758	12.3%
Arts, Entertainment, and Recreation	$198,084,054	$119,115,193	1.5%
Accommodations and Food Services	$1,048,513,180	$547,858,448	6.7%
Other Services	$490,203,804	$271,730,072	3.3%
Government and non-NAICs	$1,900,429,085	$1,564,857,549	19.1%
Total Output and GRP	**$14,031,171,857**	**$8,189,411,754**	

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

TOTAL EMPLOYMENT AND EMPLOYMENT BY SECTOR

As previously noted, existing economic conditions were evaluated for two sub-areas: north of the Grand Canyon and south of the Grand Canyon. Historical employment trends, measured by number of jobs, along with annual percentage change are presented for the Utah portions of the study area in Table 3.17-3 and for the Arizona portions of the study area in Table 3.17-6.

Table 3.17-3. Utah Counties Employment History

Year	Garfield County (No. of Jobs)	Garfield County (Annual Change)	Kane County (No. of Jobs)	Kane County (Annual Change)	San Juan County (No. of Jobs)	San Juan County (Annual Change)	Washington County (No. of Jobs)	Washington County (Annual Change)	Utah Counties of Interest Total (No. of Jobs)	Utah Counties of Interest Total (Annual Change)	Utah State Total (No. of Jobs)	Utah State Total (Annual Change)
1970	1,532		1,073		2,818		4,819		10,242		**454,612**	
1980	2,322	4.2%	1,557	3.8%	4,204	4.1%	9,442	7.0%	17,525	5.5%	**687,159**	**4.2%**
1990	2,206	-0.5%	2,374	4.3%	4,548	0.8%	21,258	8.5%	30,386	5.7%	**938,218**	**3.2%**
2000	2,985	3.1%	3,678	4.5%	5,508	1.9%	47,170	8.3%	59,341	6.9%	**1,377,859**	**3.9%**
2007	3,465	2.2%	4,583	3.2%	6,495	2.4%	74,964	6.8%	89,507	6.0%	**1,674,854**	**2.8%**
2009	3,394	-1.0%	4,395	-2.1%	6,376	-0.9%	68,930	-4.1%	83,095	-3.6%	**1,622,518**	**-1.6%**

Source: Bureau of Economic Analysis (BEA) Regional Economic Information System (BEA 2009a)
Note: Number of jobs includes full-time and part-time jobs.

North Study Area

As a group, the Utah study area counties saw positive growth from 1970 through 2007, but lost jobs between 2007 and 2009 due to the economic downturn. Washington County had the largest number of jobs among the Utah counties, accounting for 83% of all jobs in the Utah study area. Washington County also saw more total employment growth than any county in either the North Study Area or South Study Area through 2007, but experienced large job losses from 2007 through 2009.

As noted at the outset of this section, there is no comparable historical employment data specific to the portions of Coconino and Mohave counties located north of the Grand Canyon. The IMPLAN zip code level data files indicate there were approximately 1,202 jobs in the portions of Coconino County and Mohave County located north of the Grand Canyon in 2009. Employment in these areas is included in the county totals discussed subsequently for the South Study Area.

A more in-depth evaluation of 2009 employment conditions in the North Study Area is displayed in Table 3.17-4, which shows the share of jobs by industry in each county.

The largest industry, in terms of number of jobs, in both Garfield and Kane counties was accommodation and food services at 28% and 21% respectively, with government as the second largest in both cases. In San Juan County, the reverse is true with the government sector as the largest employer (29%) followed by accommodation and food services (12%). In Washington County, which provided the greatest number of total jobs in the Utah study area, the largest employment sectors were retail (13%), health care (12%) and government (11%). San Juan County is the only county in the North Study Area (or the South Study Area) that had a relatively large mining sector (6% of county jobs) in 2009.

Table 3.17-4. Utah Employment by Industry

	Garfield County	Kane County	San Juan County	Washington County	Utah Counties of Interest Total	Utah State Total
Forestry, Fishing, and Related Activities	6.9%*	3.2%*	8.1%*	0.5%*	1.4%*	0.2%
Mining	0.5%*	0.7%*	6.4%	0.6%	1.0%*	0.9%
Utilities	1.1%*	0.7%*	0.3%*	0.2%	0.3%*	0.3%
Construction	3.7%	5.3%	5.2%	8.9%	8.3%	6.2%
Manufacturing	2.2%	3.5%	3.5%	3.6%	3.6%	7.4%
Wholesale Trade	1.5%	1.0%	0.4%*	2.1%	1.9%*	3.2%
Retail Trade	8.8%	11.1%	8.2%	12.9%	12.4%	11.0%
Transportation and Warehousing	0.7%*	1.1%*	1.9%	4.8%	4.2%*	3.3%
Information	5.0%*	0.6%	0.2%	1.2%*	1.2%*	2.2%
Finance and Insurance	1.4%*	3.6%	2.8%	6.3%	5.8%*	7.0%
Real Estate, Rentals, and Leasing	0.5%*	5.2%	2.6%	6.9%	6.3%*	5.7%
Professional, Scientific, and Technical Services	2.2%	2.6%	0.6%*	5.3%	4.7%*	6.7%
Management of Companies and Enterprises	0.0%	0.0%	0.7%*	0.5%	0.5%*	1.3%
Administrative and Waste Services	1.6%*	2.0%	2.9%	4.5%	4.2%*	5.3%
Educational Services	0.3%*	0.9%*	0.7%*	1.2%	1.1%*	2.9%
Health Care and Social Assistance	9.7%*	3.0%*	8.3%*	12.2%	11.3%*	8.4%
Arts, Entertainment, and Recreation	2.6%	1.9%	1.2%	2.3%	2.3%	2.2%
Accommodation and Food Services	28.0%	21.1%	11.7%	9.1%	10.6%	6.2%
Other Services, except Public Administration	3.7%	15.1%	5.2%	5.6%	6.0%	5.2%
Government and Government Enterprises	19.4%	17.5%	29.1%	11.1%	13.0%	14.5%

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA Regional Economic Information System (REIS) data were used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 are used instead. Generally speaking, employment data from IMPLAN are approximately comparable to BEA REIS data.

* Indicates the use of IMPLAN 2009 data.

In the portions of Coconino County and Mohave County located north of the Grand Canyon, government, retail trade, construction and accommodation and food services were the largest employment sectors in 2009 and accounted for 65% of all employment in this area.

Table 3.17-5 presents the major employers (both public and private) for the North Study Area counties.

Table 3.17-5. Utah Counties Major Employers

County	Public Sector	Private Sector
Garfield	Garfield School District	Ruby's Inn
	United States Government	South Central Utah Telephone
	Garfield County	Garfield Memorial Hospital
	State of Utah	Silverado Boy's Ranch (Residential Care)
	Panguitch City	Turn About Ranch (Residential Care)

Table 3.17-5. Utah Counties Major Employers (Continued)

County	Public Sector	Private Sector
Kane	Kane County School District	Best Friends Animal Sanctuary
	United States Government	Aramark (Lake Powell Resorts)
	Kane County	Kane County Hospital
	State of Utah	Stampin' Up
	Kanab City	Honey IGA Supercenter
San Juan	San Juan School District	College of Eastern Utah - San Juan
	State of Utah	Denison Mines
	San Juan County	Libson Valley Mining
	The Navajo Nation	San Juan Hospital
	Blanding City	Montezuma Creek Community Health
Washington	Washington County School District	Intermountain Health Care
	St. George City	Wal-Mart
	United States Government	Dixie College
	Washington County	SkyWest Airlines
	City of Washington	Cross Creek Manor

Source: Utah Department of Workforce Services (2009)

South Study Area

The historical employment trend in the Arizona study area counties was similar to the Utah counties, showing positive growth through 2007, but a decrease in jobs by 2009. Since 1980, Mohave County has seen faster job growth than Coconino County, but experienced a more substantial job loss (5%) than Coconino County (2%) during the economic downturn. The Arizona counties, as a group, are larger in both size and population and therefore offer more total jobs (148,802) than the Utah study area counties (83,095).

Table 3.17-6. Arizona Counties Employment History

Year	Coconino County (No. of Jobs)	Coconino County (Annual Change)	Mohave County (No. of Jobs)	Mohave County (Annual Change)	Arizona Counties of Interest Total (No. of Jobs)	Arizona Counties of Interest Total (Annual Change)	Arizona State Total (No. of Jobs)	Arizona State Total (Annual Change)
1970	20,148		9,297		29,445		746,653	
1980	35,165	5.7%	21,285	8.6%	56,450	6.7%	1,282,615	5.6%
1990	48,543	3.3%	36,930	5.7%	85,473	4.2%	1,894,104	4.0%
2000	69,647	3.7%	54,170	3.9%	123,817	3.8%	2,795,770	4.0%
2007	85,673	3.0%	74,140	4.6%	159,813	3.7%	3,465,578	3.1%
2009	82,367	-1.9%	66,435	-5.3%	148,802	-3.5%	3,217,666	-3.6%

Source: BEA (2009a)

Note: Number of jobs includes full-time and part-time jobs.

The 2009 share of jobs by industry for the Arizona study area counties is displayed in Table 3.17-7.

Table 3.17-7. Arizona Counties Employment by Industry

	Coconino County	Mohave County	Arizona Counties of Interest Total	Arizona State Total
Forestry, Fishing, and Related Activities	0.3%	0.7%*	0.5%*	0.5%
Mining	0.4%	0.8%	0.6%	0.6%
Utilities	0.1%	0.5%	0.3%	0.4%
Construction	4.7%	7.6%	6.0%	5.7%
Manufacturing	5.2%	4.8%	5.0%	5.1%
Wholesale Trade	1.5%	1.7%	1.6%	3.5%
Retail Trade	11.2%	15.7%	13.3%	11.3%
Transportation and Warehousing	2.7%	2.7%	2.7%	2.8%
Information	0.9%	1.6%	1.2%	1.5%
Finance and Insurance	2.7%	2.9%	2.8%	6.1%
Real Estate, Rentals, and Leasing	5.9%	8.0%	6.8%	6.0%
Professional, Scientific, and Technical services	4.8%	3.5%	4.2%	6.5%
Management of Companies and Enterprises	0.1%	0.3%*	0.2%*	0.9%
Administrative and Waste Services	3.1%	5.4%	4.2%	7.8%
Educational Services	1.3%	1.1%	1.2%	1.9%
Health Care and Social Assistance	11.0%	12.3%	11.6%	10.3%
Arts, Entertainment, and Recreation	3.8%	1.7%	2.9%	2.1%
Accommodations and Food Services	14.1%	9.1%	11.9%	7.5%
Other Services, except Public Administration	5.0%	6.5%	5.6%	5.1%
Government and Government Enterprises	21.1%	13.1%	17.5%	14.2%

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA REIS data were used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 are used instead. Generally speaking, employment data from IMPLAN are comparable to BEA REIS data.

*indicates the use of IMPLAN 2009 data.

The government sector also played an important role in the South Study Area as the largest employer in Coconino County (21%) and the second largest in Mohave County (13%). Accommodation and food services accounts for 14% of all jobs in Coconino County; retail and healthcare are also significant employment sectors with each accounting for 11% of Coconino County jobs. In Mohave County, retail trade provided the most jobs at 15% of total jobs.

Table 3.17-8 presents the major employers (both public and private) for the South Study Area counties.

Table 3.17-8. Arizona Counties Major Employers

County	Public Sector	Private Sector
Coconino	City of Flagstaff	ARA Leisure Services
	Coconino County	Coconino Community College
	Flagstaff Unified School District	Flagstaff Medical Center
	Kaibab National Forest	Grand Canyon Railway
	National Park Service	Navajo Generating Station (Utilities)

Table 3.17-8. Arizona Counties Major Employers (Continued)

County	Public Sector	Private Sector
Mohave	Mohave County	American Woodmark Corp.
		Western Arizona Regional Medical Center
		Ford Proving Grounds
		Goodyear Tire and Rubber Co.
		Guardian Fiber Glass

Source: ADOC (2009a)

TOTAL EARNINGS AND EARNINGS BY SECTOR

Tables 3.17-9 and 3.17-11 display the average annual compensation per job[4] for workers in the study area for selected years from 1970 to 2009. Compensation includes both wages and benefits and all estimates have been adjusted for inflation and are shown in 2010 dollars.[5] Throughout the study area as a whole, average compensation per job has historically been below the state averages. In general, workers in the Arizona study area earn higher compensation than those in the Utah study area. A breakdown of 2009 earnings by sector for each county in the study area is provided below in Tables 3.17-10 and 3.17-12.

North Study Area

Of the Utah counties, workers in San Juan County received the highest average compensation from 1970 through 1990, but Garfield County has had the highest average earnings since 2000. Overall, average compensation per job in the Utah counties in the study area was over 28% below the Utah state average in 2009. Average compensation per job in the Utah counties has historically been lower than average compensation per job in the Arizona counties in the South Study Area.

Table 3.17-9. Utah Earnings History

Year	Garfield County (Average Compensation per Job)	Garfield County (Annual Change)	Kane County (Average Compensation per Job)	Kane County (Annual Change)	San Juan County (Average Compensation per Job)	San Juan County (Annual Change)	Washington County (Average Compensation per Job)	Washington County (Annual Change)	Utah Counties of Interest Total (Average Compensation per Job)	Utah Counties of Interest Total (Annual Change)	Utah State Total (Average Compensation per Job)	Utah State Total (Annual Change)
1970	$33,919		$25,581		$35,830		$24,971		$32,233		$37,539	
1980	$30,506	-1.1%	$24,916	-0.3%	$40,542	1.2%	$31,378	2.3%	$32,532	0.1%	$38,730	0.3%
1990	$29,528	-0.3%	$23,945	-0.4%	$30,706	-2.7%	$26,304	-1.7%	$29,034	-1.1%	$36,352	-0.6%
2000	$30,421	0.3%	$26,208	0.9%	$30,080	-0.2%	$26,637	0.1%	$29,938	0.3%	$41,338	1.3%
2007	$32,825	1.1%	$28,540	1.2%	$28,718	-0.7%	$25,583	-0.6%	$32,027	1.0%	$42,898	0.5%
2009	$31,091	-2.7%	$28,133	-0.7%	$29,493	1.3%	$25,739	0.3%	$30,593	-2.3%	$42,464	-0.5%

Source: BEA (2009a, 2009b)

Note: All estimates are shown in 2010 dollars (adjusted for inflation).

[4] Compensation per job was calculated by dividing total compensation for the county (or state) by total jobs for that county (or state). The number of jobs, and average compensation per job, includes both full- and part-time jobs.

[5] Inflation adjustments were made according to the Bureau of Labor Statistics Inflation Calculator (BLS 2011).

In 2009, average compensation per job in the portions of Coconino County and Mohave County located north of the Grand Canyon was $42,819.

In 2009, the highest paying sector in Utah as a whole, and in the study area counties, was utilities (see Table 3.17-10). The sectors providing the second highest compensation per job were government in Garfield and Washington counties and the mining industry in both Kane and San Juan counties.

Table 3.17-10. Utah Earnings by Industry

Industry	Garfield County	Kane County	San Juan County	Washington County	Utah Counties of Interest Total	Utah State Total
Forestry, Fishing, and Related Activities	$6,841*	$4,543*	$2,140*	$6,532*	$4,577*	$21,512
Mining	$39,308*	$52,521*	$66,932	$28,192	$46,892*	$78,896
Utilities	$85,676*	$92,014*	$77,266*	$80,335	$82,618*	$110,060
Construction	$22,720	$19,482	$27,267	$33,432	$32,501	$45,952
Manufacturing	$19,152	$44,654	$22,764	$44,142	$42,077	$64,129
Wholesale Trades	$27,295	$37,833	$28,140*	$37,615	$37,163*	$61,541
Retail Trades	$14,719	$19,053	$15,326	$27,566	$26,227	$28,588
Transportation and Warehousing	$16,129*	$24,066*	$27,110	$44,033	$43,050*	$54,288
Information	$47,069*	$29,516	$48,025	$34,990*	$36,895*	$55,083
Finance and Insurance	$18,875*	$20,453	$10,353	$15,819	$15,807*	$35,907
Real Estate, Rentals, and Leasing	$21,899*	$8,435	$2,439	$9,297	$9,099*	$12,579
Professional, Scientific, and Technical Services	$12,329	$14,414	$26,885*	$31,851	$30,951*	$56,099
Management of Companies and Enterprises	0	0	$50,506*	$7,100	$11,884*	$70,608
Administrative and Waste Services	$10,804*	$7,788	$20,669	$19,806	$19,420*	$29,310
Educational Services	$2,277*	$24,226*	$14,244*	$13,990	$14,320*	$27,631
Health Care and Social Assistance	$26,518*	$35,326*	$35,692*	$45,964	$44,635*	$45,628
Arts, Entertainment, and Recreation	$26,274	$25,956	$3,910	$11,440	$12,422	$16,798
Accommodations and Food Services	$20,263	$21,607	$24,238	$19,098	$19,882	$19,663
Other Services, except Public Administration	$31,123	$38,870	$41,397	$35,084	$35,885	$38,499
Government and Government Enterprises	$52,754	$47,565	$47,200	$49,557	$49,221	$58,232

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA REIS data were used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 are used instead. Generally speaking, employment data from IMPLAN are comparable to BEA REIS data. All estimates are shown in 2010 dollars (adjusted for inflation).

* indicates the use of IMPLAN 2009 data.

In 2009, the highest-paying sectors in the portions of Coconino County and Mohave County located north of the Grand Canyon were finance and insurance; mining; government; transportation and warehousing; and health and social services. Average compensation in each of these sectors was more than $50,000 per job.

South Study Area

Average compensation per job was about 10% higher in Coconino County in 2009 than in Mohave County and average compensation has been higher in Coconino County since 1980. Compensation per job in both Arizona counties, however, has traditionally been 10%–20% lower than the statewide average in Arizona (Table 3.17-11).

Table 3.17-11. Arizona Earnings History

Year	Coconino County (Average Compensation per Job)	Coconino County (Annual Change)	Mohave County (Average Compensation per Job)	Mohave County (Annual Change)	Arizona Counties of Interest Total (Average Compensation per Job)	Arizona Counties of Interest Total (Annual Change)	Arizona State Total (Average Compensation per Job)	Arizona State Total (Annual Change)
1970	$36,833		$40,575		$38,014		$41,387	
1980	$36,218	-0.2%	$34,110	-1.7%	$35,423	-0.7%	$40,958	-0.1%
1990	$34,246	-0.6%	$31,617	-0.8%	$33,110	-0.7%	$38,866	-0.5%
2000	$36,579	0.7%	$35,913	1.3%	$36,288	0.9%	$46,857	1.9%
2007	$38,700	0.8%	$36,005	0.0%	$37,450	0.5%	$48,714	0.6%
2009	$38,382	-0.4%	$34,680	-1.9%	$36,729	-1.0%	$47,926	-0.8%

Source: BEA (2009a, 2009b)

Note: All estimates are in shown in 2010 dollars (adjusted for inflation).

The Arizona counties of interest offered higher compensation in most sectors than the Utah counties, except for jobs in the mining, utilities and “other” sectors. In Coconino County, the highest paying sector was manufacturing, followed by government. In Mohave County, the utilities sector had the highest compensation per job followed by the health care and social assistance sector.

Table 3.17-12. Arizona Earnings by Industry

Industry	Coconino County	Mohave County	Arizona Counties of Interest Total	Arizona State Total
Forestry, Fishing, and Related Activities	$9,793	$15,760*	$13,671*	$28,382
Mining	$15,670	$37,404	$28,799	$62,519
Utilities	$57,330	$82,042	$75,344	$123,300
Construction	$38,130	$29,666	$33,303	$52,075
Manufacturing	$71,084	$48,867	$61,520	$79,313
Wholesale Trades	$40,715	$41,713	$41,205	$72,414
Retail Trades	$26,683	$29,679	$28,288	$32,580
Transportation and Warehousing	$47,757	$39,890	$44,183	$53,158
Information	$28,116	$34,547	$31,864	$63,223
Finance and Insurance	$22,549	$32,418	$27,243	$50,540
Real Estate, Rentals, and Leasing	$12,891	$10,285	$11,524	$21,063
Professional, Scientific, and Technical Services	$32,116	$35,319	$33,327	$62,424
Management of Companies and Enterprises	$51,072	$49,729*	$50,273*	$78,848
Administrative and Waste Services	$22,382	$22,754	$22,601	$34,518
Educational Services	$14,988	$25,827	$19,412	$37,439
Health Care and Social Assistance	$55,785	$55,941	$55,860	$56,158
Arts, Entertainment, and Recreation	$18,234	$16,362	$17,731	$25,506
Accommodation and Food Services	$23,485	$17,816	$21,524	$23,583
Other Services, except Public Administration	$28,897	$29,508	$29,213	$33,143
Government and Government Enterprises	$61,056	$54,440	$58,820	$63,982

Sources: BEA (2009b) and IMPLAN (2009).

Note: BEA REIS data was used where available. However, in certain cases the BEA withholds data to avoid disclosure of confidential information. These cases are denoted with an asterisk and data from IMPLAN 2009 is used instead. Generally speaking, employment data from IMPLAN is comparable to BEA REIS. All estimates are shown in 2010 dollars (adjusted for inflation).

* Indicates the use of IMPLAN 2009 data.

TOURISM-RELATED ECONOMY

The tourism “sector” is not a clearly defined, specific industry within a local economy, but rather reflects the portions of the economic activity of multiple sectors (such as retail trade; accommodation and food services; and arts, entertainment and recreation) that can be attributed to expenditures by tourist visitors. Consequently, standardized data on the tourism-related economy are not typically available. However, a substantial portion of tourism within the study area is due to nature-based travel to visit public lands. As shown in Tables 3.17-13 and 3.17-14 on the following pages, facilities managed by the NPS, including national parks, national monuments and national recreation areas, generated nearly 12 million recreational visits to the study area in 2008. NPS data regarding visitation, visitor spending and the economic impacts of park activities in the local area were applied to provide a baseline for evaluating the tourism-related economy of the study area.

The data provided in this section were obtained from a 2009 study sponsored by the NPS that estimated the visitation and economic impact of National Parks and National Monuments across the United States. It should be noted that assessing the economic impact of tourism within the study area based on NPS managed lands provides only an order of magnitude, minimum representation of the total tourism-based economy. Examples of other tourist activities that are not included in this measure include Route 66 historic/scenic travel, National Forest visitation, and “snowbird” visits to St. George, Utah.

Figure 3.17-1 provides a map of the study area showing the locations of NPS managed parks and monuments included in the 2009 NPS study.

North Study Area

Table 3.17-13 displays the visitation and estimated economic impacts for the National Parks and National Monuments located within the North Study Area. The jobs, labor income, and value added include the direct and secondary (multiplier) effects from visitor spending and National Park payroll. According to a 2005 NAU tourism study, 17% of visitors access the Grand Canyon from the north rim. Based on this visitation distribution, 17% of Grand Canyon impacts were attributed to the North Study Area, and the remaining 83% were attributed to the South Study Area (NAU 2005).

Glen Canyon National Recreation Area (GCNRA) sits atop the historical channel of the Colorado River and, consequently, is physically located in both the North and South Study Areas. The North Study Area community of Lees Ferry is largely supported by visitors to the GCNRA. However, since the data do not exist to apportion visitor spending between the two study areas, and the city of Page in the South Study Area is the larger gateway community to the GCNRA, these economic benefits are reflected in the data for the South Study Area.

Based on the data summarized in Table 3.16-13, the tourism industry in the North Study Area supported 8,306 jobs (approximately 10% of total jobs in the area) and contributed over a quarter of a billion dollars to GRP in 2008, not including any tourist visits unrelated to NPS managed facilities. Zion National Park, located in Washington County, is the most visited NPS facility in the North Study Area and also generates the most jobs and value added for the area. Collectively, Zion and Bryce Canyon account for approximately two thirds of recreation visits and value added within the North Study Area.

Average labor income from tourism-based jobs was relatively low ($21,879) compared to the average compensation per job data provided earlier in this section. Also, tourism in the North Study Area is more seasonal than tourism in the South Study Area (personal communication, Carl Taylor and Bill Towler, Coconino County 2011).

Table 3.17-13. North Study Area Tourism Impacts, 2008

Park Unit	Recreation Visits	Non-local Visitor Spending ($000's)	Total Jobs‡	Total Labor Income‡ ($000's)	Total Value Added‡ ($000's)
Utah					
Zion National Park	2,690,154	$141,446	3,253	$84,028	$118,667
Bryce Canyon National Park	1,043,321	$89,983	1,875	$35,717	$53,239
Grand Staircase-Escalante National Monument	NA	NA	NA	NA	NA
Rainbow Bridge National Monument	95,567	$4,604	94	$1,959	$2,982
Capitol Reef National Park	604,811	$28,198	607	$12,430	$18,045
Canyonlands National Park†	174,686	$14,196	346	$7,820	$10,807
Natural Bridges National Monument	91,838	$4,435	98	$2,253	$3,294
Arizona (North of Grand Canyon National Park)					
Grand Canyon National Park*	752,303	$72,774	1,967	$35,586	$52,923
Pipe Spring National Monument	47,418	$2,285	66	$1,936	$1,412
Grand Canyon-Parashant National Mondument	NA	NA	NA	NA	NA
Vermilion Cliffs National Monument	NA	NA	NA	NA	NA
Study Area Total	**5,500,098**	**$357,921**	**8,306**	**$181,728**	**$261,368**

Source: Stynes (2009).

Note: All estimates are in 2010 dollars (adjusted for inflation). Numbers may not add to total due to rounding.

* Based on the results of the 2005 NAU tourism study of Grand Canyon National Park, 83% of the visitation, visitor spending, and economic impacts of the park were allocated to the south study area and 17% to the north study area (corresponding to relative visitation of the two rims).

† The northern portion of Canyonlands National Park lies outside the study area. Visitors accessing the northern portion (Island in the Sky District) of the Park were assumed to base their visit from Moab, in Grand County. Based on the visitation distribution of Island in the Sky District relative to the Maze and Needles Districts, 40% of the visitation and economic impact was assumed to occur within the study area and was included in the table.

‡ Total Jobs, Total Labor Income, and Total Value Added include both visitor impacts and NPS payroll impacts.

South Study Area

Visitation and estimated economic impacts for National Parks and National Monuments located within the South Study Area are displayed in Table 3.17-14. As discussed previously, 83% of the Grand Canyon impacts were attributed to the South Study Area. It should also be noted that while portions of the GCNRA, lie on the north side of the Colorado River, most visitors access the park from the city of Page, so the tourism impacts were considered to occur in the South Study Area.

Table 3.17-14. South Study Area Tourism Impacts, 2008

Park Unit	Recreation Visits	Non-local Visitor Spending ($000's)	Total Jobs‡	Total Labor Income‡ ($000's)	Total Value Added‡ ($000's)
Arizona (South of Grand Canyon National Park)					
Grand Canyon National Park*	3,673,011	$355,309	9,603	$173,741	$258,390
Wupatki National Monument	239,157	$11,522	301	$8,275	$11,321
Sunset Crater Volcano National Monument	209,399	$10,088	200	$4,029	$6,236
Walnut Canyon National Monument	101,833	$4,906	97	$1,960	$3,032
Glen Canyon National Recreation Area	1,947,507	$133,559	2,667	$66,433	$101,098
Study Area Total	**6,170,907**	**$515,385**	**12,868**	**$254,438**	**$380,077**

Source: Stynes (2009).

Note: All estimates are in 2010 dollars (adjusted for inflation). Numbers may not add to total due to rounding.

* Based on the results of the 2005 NAU tourism study of Grand Canyon National Park, 83% of the visitation, visitor spending and economic impacts of the park were allocated to the south study area and 17% to the north study area (corresponding to relative visitation of the two rims).

‡ Total Jobs, Total Labor Income, and Total Value Added include both visitor impacts and NPS payroll impacts.

Tourism associated with NPS-managed lands in the South Study Area is a significant contributor to the overall regional economy. Visitors and NPS payroll generated 12,868 jobs (9% of total jobs) and added $380 million to GRP in 2008. Not surprisingly, Grand Canyon National Park creates the largest economic impact supporting 9,600 jobs and generating $258 million in value added in the South Study Area. As was the case in the North Study Area, average labor income from tourism-based jobs in the South Study Area was relatively low ($19,773) compared to the average compensation per job data provided earlier in this section.

MINING-RELATED ECONOMY

The mining industry has played a role in the history and development of the entire study area, with the cultural and economic effects of mining being most pronounced in the North Study Area. In 2009, the mining industry accounted for 1% of all jobs in the North Study Area and less than 0.5% of all jobs in the South Study Area (IMPLAN 2009). It is important to note, however, that the discussion of current and historical mining-related employment in this section reflects only direct mining jobs. These data cannot be directly compared to the previous discussion regarding the economic contribution of tourism, which included indirect and induced employment (multiplier effects).

Among all study area counties, the mining sector is largest in San Juan County, Utah, where it accounted for over 6% of all jobs. San Juan County has an extensive mining history, including uranium and other minerals. Uranium has been mined and milled in the County since the early 1900s (San Juan County 2011). Across the study area, the share of jobs in the mining industry is relatively low but the average compensation per mining job has historically been higher than the industry-wide averages shown in Table 3.17-10.

North Study Area

Table 3.17-15 depicts the history of mining-related employment in Utah study area from 1970 through 2009. Until the early 2000s, mining was most prevalent in San Juan County, which accounted for over three-fourths of the mining jobs in the study area throughout the 1970s and 1980s. The data shown in Table 3.17-15 are from the Bureau of Economic Analysis. Data from the BLS and the Utah Department of Workforce Solutions (which are available only from 2001 forward) provide similar estimates of mining employment over the most recent decade. It should be noted, however, that the older historical data for mining in Garfield County and Kane County are frequently suppressed due to BEA's concerns about disclosing data when there are few employers reporting job counts. Consequently, historical mining jobs in these counties—and particularly uranium mining employment attributable to Energy Fuels during the 1980s—are not well documented in the public data sources.

Table 3.17-15. Utah Mining Sector Employment History (number of jobs)

Decade	Garfield County	Kane County	San Juan County	Washington County	Utah Counties of Interest Total	Utah State Total
1970s (average)	NA	NA	751	31	782	14,311
1980s (average)	104	19	702	75	900	13,788
1990s (average)	NA	NA	332	186	517	9,546
2000s (average)	NA	11	289	368	668	11,065

Source: BEA (2009a)

Note: Calculations of job averages for each decade based only on years for which data were disclosed.

Table 3.17-16 provides greater detail for the current mining-related economy of the North Study Area. In 2009, mining sand and gravel supported the most jobs, but copper mining contributed the most to GRP.

Jobs in the coal mining industry averaged the highest compensation, followed by jobs in oil and gas. According to the RFD, the primary mineral commodity located in the withdrawal area is uranium, which is classified as a metal ore. Mining gold, silver, and metal ore (including uranium) supported 56 jobs making an average of $75,542 per year in 2009.

Table 3.17-16. North Study Area Mining Detail, 2009

Description	Jobs	Labor Income	Average Compensation per Job	Value Added
Extraction of Oil and Natural Gas	93	$7,851,679	$84,444	$17,703,467
Mining Coal	3	$261,258	$103,707	$516,714
Mining Iron Ore	0	$0	$0	$0
Mining copper, Nickel, Lead, and Zinc*	128	$9,882,023	$77,019	$39,873,130
Mining Gold, Silver, and other Metal Ore**	56	$4,226,860	$75,542	$20,903,081
Mining and Quarrying Stone	32	$1,077,825	$33,406	$2,506,104
Mining and Quarrying Sand, Gravel, Clay, and Ceramic and Refractory Minerals	176	$6,698,279	$38,004	$9,831,786
Mining and Quarrying other Nonmetallic Minerals	57	$2,757,423	$48,069	$7,363,364
Drilling Oil and Gas Wells	31	$1,335,309	$42,974	$5,800,388
Support Activities for Oil and Gas Operations	65	$3,158,669	$48,352	$3,358,413
Support Activities for other Mining	11	$581,823	$51,074	$1,163,192
Total	**653**	**$37,831,147**	**$57,896**	**$109,019,639**

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

* Standard NAICS description for this sector. Only copper occurs in the region near the Grand Canyon.

** Includes uranium mining and milling.

South Study Area

The mining sector in Coconino and Mohave counties has historically supported fewer jobs than in the Utah counties in the North Study Area (Table 3.17-17). In recent decades, the number of mining jobs has been evenly distributed between the two study area counties. Although mining jobs declined after the 1970s, the most recent decade has seen an increase in mining employment in both Coconino County and Mohave County.

Table 3.17-17. Arizona Mining Sector Employment History (number of jobs)

Decade	Coconino County	Mohave County	Arizona Counties of Interest Total	Arizona State Total
1970s (average)	55	478	533	24,109
1980s (average)	108	369	477	17,943
1990s (average)	171	169	339	15,870
2000s (average)	266	279	545	14,118

Source: BEA (2009a)

Note: Calculations of job averages for each decade based only on years for which data were disclosed.

Mining sector details by type of mining in the South Study Area are displayed in Table 3.17-18. Mining copper accounted for 71% of mining jobs and 81% of value added from mining in 2009. Mining gold, silver, and other metal ore, which includes uranium mining, supported only two jobs in the South Study Area in 2009, with an average annual compensation of $56,364.

Table 3.17-18. South Study Area Mining Detail, 2009

Description	Jobs	Labor Income	Average Comp per Job	Value Added
Extraction of Oil and Natural Gas	15	$279,477	$19,227	$660,095
Mining Coal	5	$519,076	$103,708	$1,026,625
Mining Iron Ore	0	$0	$0	$0
Mining Copper, Nickel, Lead, and Zinc*	244	$15,110,495	$62,049	$61,038,796
Mining Gold, Silver, and other Metal Ore**	2	$90,183	$56,364	$448,624
Mining and Quarrying Stone	17	$827,491	$50,129	$1,926,565
Mining and Quarrying Sand, Gravel, Clay, and Ceramic and Refractory Minerals	14	$725,061	$50,444	$1,065,001
Mining and Quarrying other Nonmetallic Minerals	32	$1,883,340	$59,267	$5,029,327
Drilling Oil and Gas Wells	11	$760,292	$68,100	$3,401,548
Support Activities for Oil and Gas Operations	0	$0	$0	$0
Support Activities for other Mining	6	$551,475	$87,034	$1,092,829
Total	**345**	**$279,477**	**$60,166**	**$75,689,410**

Source: IMPLAN (2009)

Note: Numbers may not add to total due to rounding.

* Standard NAICS description for this sector. Only copper occurs in the region near the Grand Canyon.

** Includes uranium mining and milling.

PERSONAL INCOME

Tables 3.17-19 and 3.17-20 depict median household income (MHI) for the North and South study areas in 2000 and 2009. All income is adjusted for inflation and shown in 2010 dollars. Median income data was only available by county so the North Study Area includes only the Utah counties, and the South Study Area comprises the Arizona counties.

North Study Area

The state of Utah had a higher MHI than the nation in both 2000 and 2005–2009,[6] but the Utah counties in the study area all had a MHI below both the state and national medians. However, this gap narrowed between 2000 and 2005–2009 in all counties in the South Study Area except Kane County. Washington County had the highest MHI at $49,527 and San Juan County had the lowest MHI in the North Study Area at $36,803 per year.

The communities in closest proximity to the North Parcel are Fredonia, Arizona; Colorado City, Arizona; the Kaibab Paiute Tribe; and Kanab, Utah. According to the 2005–2009 American Community Survey 5-year estimate (Census Bureau 2009), Colorado City had the highest MHI ($46,268) of these communities, followed by Kanab ($41,149) and then Fredonia ($39,244). The MHI for the Kaibab Paiute Tribe was $26,750. Blanding, Utah, where uranium mined in the region is most likely to be processed, had an MHI

[6] The most recent available personal income data is from the American Community Survey and reflects the 5-year average for the 2005–2009 period.

of $38,182.[7] Colorado City and Blanding both show median incomes above their county averages, but the median incomes of both Fredonia and Kanab are below their counties' averages. The MHI for the Kaibab Paiute Tribe was considerably lower than the MHI for the other communities in close proximity to the North Parcel.

Table 3.17-19. Utah Median Household Income

	2000	2005–2009	Annual Change
United States	$53,177	$52,269	-0.2%
Utah	$57,903	$56,555	-0.3%
Garfield County	$44,548	$45,597	0.3%
Kane County	$43,367	$41,991	-0.4%
San Juan County	$35,630	$36,803	0.4%
Washington County	$47,121	$49,527	0.6%

Sources: Census Bureau (2000, 2009)
Note: All estimates are in 2010 dollars (adjusted for inflation).

South Study Area

The 2009 median household income in Coconino County ($49,051) was slightly below the state median of $51,121, while MHI in Mohave County ($40,816) was about 14% below the state average. Despite a decrease in MHI on the state and national level, both Coconino and Mohave counties showed positive small increases in MHI between 2000 and 2005–2009.

Table 3.17-20. Arizona Median Household Income

	2000	2005–2009	Annual Change
United States	$53,177	$52,269	-0.2%
Arizona	$51,358	$51,121	-0.1%
Coconino County	$48,443	$49,051	0.1%
Mohave County	$39,915	$40,816	0.2%

Sources: Census Bureau (2000, 2009)
Note: All estimates are in 2010 dollars (adjusted for inflation).

The communities proximate to the East and South parcels include Bitter Springs CDP, Page, and Tusayan—all in Coconino County, Arizona. In 2005–2009, the MHI in Bitter Springs CDP was $42,369, which was $6,000 lower than Coconino County. The MHI in both Page ($55,967) and Tusayan ($51,513) exceeded the Coconino County MHI.[8]

LABOR FORCE AND UNEMPLOYMENT

The labor force of an area is the population of working-age residents that are currently employed or are unemployed but actively seeking work. It is important to note that "unemployed" is specifically defined

[7] These figures were adjusted for inflation and are shown in 2010 dollars for comparison to the county level data in Tables 3.17-19 and 3.17-20.

[8] Median household incomes reflect U.S. Census Bureau, 2005–2009 American Community Survey 5-year estimates (Census Bureau 2010a) and were adjusted for inflation (shown in 2010 dollars) for comparison to the county level data in Tables 3.16-19 and 3.16-20.

and does not include the entire non-working population. According to the BLS, unemployed individuals are "persons aged 16 years and older who had no employment during the reference week, were available for work, except for temporary illness, and had made specific efforts to find employment sometime during the 4-week period ending with the reference week. Persons who were waiting to be recalled to a job from which they had been laid off need not have been looking for work to be classified as unemployed" (BLS 2010). The unemployment rate reflects the number of unemployed persons as a percentage of the total labor force.

As a result of the economic recession that began in late 2008, unemployment in communities across the United States rose sharply and the study area counties were no exception. In 2009, the U.S. unemployment rate rose to 9.3%, an increase of 3.5 percentage points over the previous year; and in 2010 it rose again, though not as dramatically, to 9.6%. Of the entire study area, the only counties with unemployment rates below the 2010 national average were Kane County, Utah (8.2%), and Coconino County, Arizona (8.9%).

North Study Area

Figure 3.17-2 illustrates the unemployment trends in the United States, Utah, and the counties of interest from 2000 to 2010.

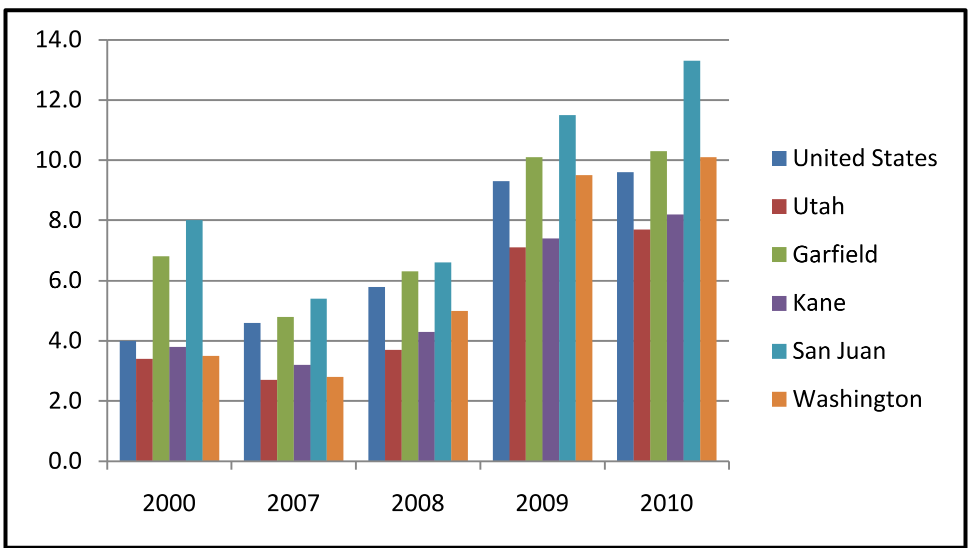

Figure 3.17-2. Utah unemployment rates, compared with rates in United States and counties of interest, 2000–2010 (Source: BLS 2010).

The state of Utah has consistently maintained unemployment rates at or below than the national average. While unemployment rates in Kane and Washington counties have typically been similar to the state average, Garfield and San Juan counties have generally had unemployment rates two to three percentage points higher than Utah's average. From 2008 to 2009, unemployment rates in all of the Utah counties in the study area rose by three to five percentage points. As of 2010, San Juan County had the highest unemployment rate (13.3%), not only of the Utah counties of interest, but of the entire study area. Kane County had the lowest unemployment rate of the study area at 8.2%.

South Study Area

Unemployment rates for Arizona and the South Study Area counties of interest are displayed graphically in Figure 3.17-3.

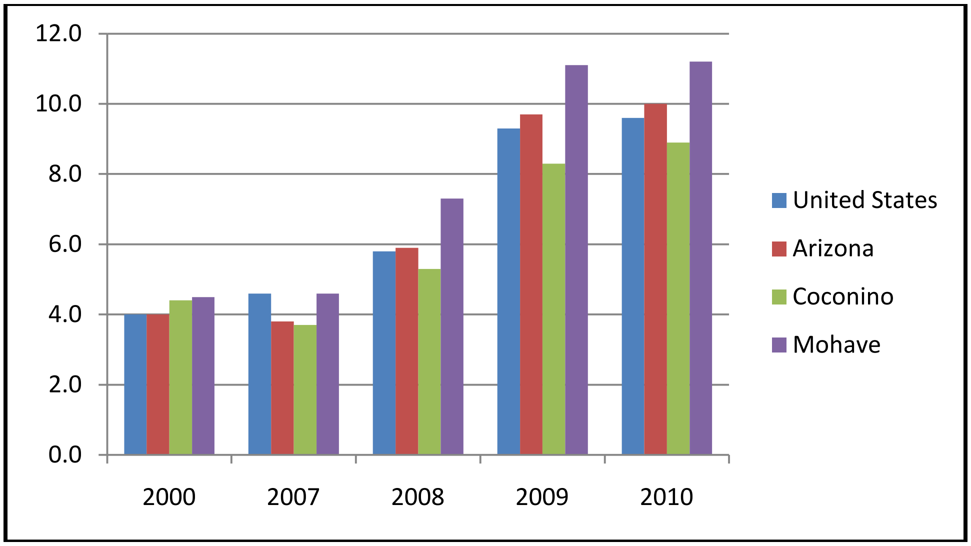

Figure 3.17-3. Arizona unemployment rates, compared with rates in United States and counties of interest, 2000–2010 (Source: BLS 2010).

Arizona experienced trends in unemployment similar to Utah and the United States as a whole in response to the economic crisis of 2008. Though often showing historical unemployment rates higher than Utah, Arizona's unemployment rate stayed below the U.S. average until 2008. In 2009 the Arizona unemployment rate increased by almost four percentage points to reach 9.7%, and by 2010 the unemployment rate had risen to 10%. Unemployment in Coconino County reached 8.9% in 2010 and Mohave County had 11.2% unemployment in 2010, higher than both the state and national unemployment rates.

Taxes and Revenues

The states of Arizona and Utah, as well the counties and cities within the study area, raise revenues from a variety of different sources. At the state level, income taxes and sales-related taxes (termed transaction privilege taxes in Arizona) are the largest sources of revenue. At the local government level, sales-related taxes and property taxes are typically the largest sources of revenue for cities and counties.

The different levels of future mining activity anticipated to result from the alternatives considered in this EIS would directly affect severance tax revenues in Arizona. The alternatives would also likely affect state income tax revenues and sales-related taxes at both the state and local levels.

Property tax revenues are also a significant source of revenue for local governments. Although the uranium mines would be located on federal lands, they would be subject to centrally assessed property taxes based on the present value of the discounted cash flow of their operations. Denison Mines, which owns and operates the White Mesa Mill in San Juan County (where uranium mined from the proposed withdrawal areas would be anticipated to be processed), is one of that county's largest taxpayers (personal communication, Rick Bailey, County Administrator 2011). Unlike some other resources that are extracted from public lands (e.g., oil, natural gas and coal), uranium mines operating on federal lands do not pay royalties to the federal government.

The historical tax revenues described in this section are as reported by official sources and are in nominal dollars (not updated for inflation to 2010 dollars).

North Study Area (Utah)

The following discussion focuses on potentially affected State of Utah revenues and revenues for local governments in the Utah portion of the study area. Although the northern portions of Coconino County and Mohave County (in Arizona) are also located in the North Study Area, those areas are discussed later in conjunction with other Arizona areas because of differences in the revenue mechanisms, terminology, and accounting between the two states.

Table 3.17-21 depicts annual state income tax revenues and state sales and use tax revenues for the State of Utah for the fiscal years from 2005 through 2010. In 2010, the State's general fund received about $2.4 billion in income tax revenue and $1.4 billion in sales and use tax revenues. The combined total from these two major revenue sources ($3.8 billion) was about 21% less than the State received from these sources in 2007 ($4.8 billion), reflecting the impact of the recent recession and slow recovery.

Table 3.17-21. State of Utah Income Tax and Sales Tax Revenues 2005–2010

Year	State Income Tax* Revenue	State Income Tax* Annual Change	Sales and Use Tax** Revenue	Sales and Use Tax** Annual Change
2005	$2,137,477,300		$1,634,522,084	
2006	$2,653,331,323	24%	$1,806,264,423	11%
2007	$2,984,750,333	12%	$1,857,813,410	3%
2008	$3,006,720,826	1%	$1,739,384,630	-6%
2009	$2,587,970,200	-14%	$1,547,472,747	-11%
2010	$2,387,593,439	-8%	$1,402,678,571	-9%

Sources: State of Utah (2009); Utah State Tax Commission (2010).

*Includes personal and corporate income taxes.

**General fund unrestricted sales tax revenue. Excludes earmarked revenues and local sales tax revenues.

Utah's local governments within the North Study Area have also been substantially affected by the recession. Table 3.17-22 depicts annual sales-related tax revenues for the counties within the study area and the communities of particular focus identified in Section 3.16. These figures include the local sales and use tax distribution from the State of Utah; county option sales taxes; tourism, recreation, cultural and convention facilities tax revenues; State-collected county transient room tax revenues; municipality transient room tax revenues; and resort community tax revenues.

Except for Kane County, which added the county option sales tax in FY2008, the Utah counties have experienced substantial reductions in sales-related tax revenues since 2008. This trend is somewhat exaggerated in Table 3.17-22, because Garfield County began collecting county transient room tax revenues locally in 2007 and these local collections are not included in the data shown in the table.

The fiscal effects of the recession have been even more pronounced for the City of Blanding and the City of Kanab. Blanding's sales-related tax revenues have declined by over 20% since 2008, while Kanab's sales-related tax revenues have diminished by about 16% during the same period.

Table 3.17-22. Sales-related Tax Revenues for Utah Communities in the Study Area: 2005–2010

County/City	2005	2006	2007	2008	2009	2010
Garfield County*	$1,146,182	$1,283,957	$1,272,839	$782,764	$729,052	$703,965
Annual Change		*12%*	*-1%*	*-39%*	*-7%*	*-3%*
Kane County**	$733,773	$846,704	$884,696	$1,220,315	$1,524,124	$1,591,769
Annual Change		*15%*	*4%*	*38%*	*25%*	*4%*
San Juan County	$1,403,797	$1,573,582	$2,014,513	$2,396,665	$2,122,529	$2,054,751
Annual Change		*12%*	*28%*	*19%*	*-11%*	*-3%*
Washington County	$8,022,474	$9,527,703	$10,370,372	$11,518,035	$10,861,989	$10,484,565
Annual Change		*19%*	*9%*	*11%*	*-6%*	*-3%*
County Totals	**$11,306,226**	**$13,231,946**	**$14,542,420**	**$15,917,779**	**$15,237,694**	**$14,835,050**
Annual Change		***17%***	***10%***	***9%***	***-4%***	***-3%***
City of Blanding	$397,096	$459,346	$555,627	$578,278	$526,662	$451,781
Annual Change		*16%*	*21%*	*4%*	*-9%*	*-14%*
City of Kanab	$950,092	$1,107,955	$1,239,816	$1,287,368	$1,184,224	$1,085,337
Annual Change		*17%*	*12%*	*4%*	*-8%*	*-8%*

Source: Utah State Tax Commission (2007, 2010)

Note: Includes local sales and use tax distribution from State of Utah (State of Utah 2009); county option sales taxes; tourism, recreation, cultural and convention facilities tax revenues; State-collected county transient room tax revenues; municipality transient room tax revenues and resort communities tax revenues.

* Garfield County began collecting county transient room taxes locally in 2007. Local collections are not reflected in this table.

** Kane County added the county option sales tax beginning in FY2008.

South Study Area (Arizona)

Table 3.17-23 depicts annual state income tax revenues and the sales-related tax revenues (transaction privilege and use tax revenues) supporting the State of Arizona's general fund for the fiscal years from 2005 through 2010. In 2010, the State's general fund received about $2.2 billion in income tax revenue and $3.4 billion in sales-related tax revenues. The combined total from these two major revenue sources ($5.6 billion) was about 35% less than the State received from these sources in 2007 ($8.6 billion), reflecting the severe impact of the recent recession in the State of Arizona.

Table 3.17-23 also depicts the severance taxes the State of Arizona has collected from mining operations over the 2005 through 2010 period. The State collected about $29 million in mining severance taxes in 2010, an increase of about 60% over the $18 million collected in 2009. However, mining severance tax collections in 2010 remained substantially lower than the $44 million collected in 2007 and in 2008. About 80% of the severance tax revenues collected by the State of Arizona are distributed back to cities and towns throughout the state using the same formula employed to distribute transaction privilege tax revenues (sales tax revenues) to local governments.

Annual sales-related tax revenues for the Arizona counties within the study area, and the communities of particular focus identified in Section 3.16, are shown in Table 3.17-24. These figures include the transaction privilege, use and severance tax revenues distributed to local governments by the State of Arizona; municipal privilege tax collection program revenues (optional taxes that have been enacted by most Arizona cities); and specific excise taxes that have been enacted by Coconino and Mohave counties. Note that Bitter Springs and Tusayan were Census Designated Places (CDPs), not municipalities, and did not have taxing authority.[9] Revenue data for the Kaibab Paiute Tribe was not available from the Arizona Department of Revenue Annual Reports.

[9] In May 2010, Tusayan voters elected to incorporate their community. Tusayan will have municipal taxing authority in future years.

Table 3.17-23. State of Arizona Income Tax and Sales-related Tax Revenues, and Mining Severance Tax Collections, 2005–2010

Year	State Income Tax* Revenue	State Income Tax* Annual Change	Transaction Privilege, Use and Severance Tax** Revenue	Transaction Privilege, Use and Severance Tax** Annual Change	Mining Severance Tax Collections*** Revenue	Mining Severance Tax Collections*** Annual Change
2005	$3,170,987,163		$3,674,989,952		$16,399,086	
2006	$4,089,641,855	29%	$4,291,363,227	17%	$30,439,973	86%
2007	$4,089,906,556	0%	$4,550,828,973	6%	$43,549,005	43%
2008	$3,506,425,271	-14%	$4,378,075,201	-4%	$43,751,613	0%
2009	$2,432,366,069	-31%	$3,774,696,057	-14%	$18,210,071	-58%
2010	$2,200,844,986	-10%	$3,444,458,834	-9%	$29,098,554	60%

Source: Arizona Department of Revenue (2005, 2006, 2007, 2008, 2009, 2010)

* Includes personal and corporate income tax revenues.

** Includes revenues to state general fund only. Excludes revenues distributed to local governments.

*** Reflects total severance taxes collected from mining operations. Approximately 80% of this revenue is distributed back to cities and counties.

The effects of the recession on the fiscal conditions of the Arizona counties in the study area, and the communities of particular focus, are evident from the data shown in Table 3.17-24. The percentage reduction in local government revenues has not been as dramatic as the decrease in State revenues described previously. Combined sales-related tax revenues for the two counties were about $61.4 million in FY2010, approximately 16% lower than their peak of $73.2 million in 2008. Sales-related tax revenues in Colorado City were about $175,000 less in FY2010 than in FY2007 (a 25% decrease), while FY2010 revenues in Fredonia were about $85,000 lower than their peak in 2008 (a 23% decrease). The City of Page has fared the best from a fiscal standpoint, with sales-related tax revenues continuing to increase through 2009 before dropping by about 8% in FY2010.

Table 3.17-24. Sales-related Tax Revenues for Arizona Communities in the Study Area: 2005–2010

County/City	2005	2006	2007	2008	2009	2010
Coconino County	$34,019,665	$38,283,734	$42,065,640	$45,126,208	$41,600,577	$38,490,726
Annual Change		*13%*	*10%*	*7%*	*-8%*	*-7%*
Mohave County	$23,870,257	$28,158,529	$29,769,338	$28,116,730	$25,516,764	$22,950,000
Annual Change		*18%*	*6%*	*-6%*	*-9%*	*-10%*
County Totals	**$57,889,922**	**$66,442,263**	**$71,834,978**	**$73,242,938**	**$67,117,341**	**$61,440,726**
Annual Change		***15%***	***8%***	***2%***	***-8%***	***-8%***
Bitter Springs CDP**	NA	NA	NA	NA	NA	NA
Annual Change		*NA*	*NA*	*NA*	*NA*	*NA*
Colorado City	$550,485	$637,559	$706,633	$612,817	$592,131	$529,850
Annual Change		*16%*	*11%*	*-13%*	*-3%*	*-11%*
Town of Fredonia	$168,313	$216,260	$245,509	$373,328	$325,885	$288,870
Annual Change		*28%*	*14%*	*52%*	*-13%*	*-11%*
Kaibab Paiute Tribe	NA	NA	NA	NA	NA	NA
Annual Change		*NA*	*NA*	*NA*	*NA*	*NA*
City of Page	$5,119,945	$6,337,522	$6,535,415	$7,295,794	$7,687,621	$7,098,600
Annual Change		*24%*	*3%*	*12%*	*5%*	*-8%*
Tusayan CDP**	NA	NA	NA	NA	NA	NA
Annual Change		*NA*	*NA*	*NA*	*NA*	*NA*

Source: Arizona Department of Revenue (2005, 2006, 2007, 2008, 2009, 2010)

Note: Includes transaction privledge and severance tax distributions to municipalities and counties, municipal privledge tax collection program revenues and specific exise taxes levied by the counties.

* Bitter Springs and Tusayan are Census Designated Places, not municipalities, and do not levy taxes.

Recreation and Environmental Economics

The economic benefit of recreation is a different concept from the economic impact of spending on recreation (or other tourism) activities. Earlier, this section summarized the economic contribution from spending by visitors to recreation sites on NPS managed lands, including National Parks and National Monuments in the study area. The following discussion, however, considers the additional value of the recreation experience to the visitors themselves.

The term "economic benefits" describes how much people value their own participation in recreation activities, over and above what they have to pay to participate. This concept can also be described in terms of "consumer's surplus," or the amount that individuals would be willing to pay to be able to participate in particular recreation activities (or how much they would be willing to accept to forego participation in those activities).

Economists consider outdoor recreation, and other types of "environmental amenities," to be examples of what are termed "non-market goods," meaning that they are things that people value but that do not have explicit prices determined by markets. Other examples of non-market goods include improvements in air or water quality, reductions in crime rates, and living in proximity to beaches or protected natural areas.

Economists have developed a variety of techniques for establishing the value of non-market goods, including both "stated preference" and "revealed preference" models. In stated preference models, such as the contingent valuation method, a value is ascertained directly through surveys intended to identify a person's willingness to pay (WTP). In revealed preference models, such as the Travel Cost Method, a value is inferred based on consumer behavior. The economic benefit is a function of the activity cost and the participant's WTP. For example, if someone is willing to pay $55 to go fishing for a day, but the actual cost of their fishing trip is only $30, they receive a net economic benefit of $25 per day from their fishing experience.

RECREATION BENEFITS IN AND NEAR THE PROPOSED WITHDRAWAL AREAS

The volume of non-consumptive recreational use in and near the proposed withdrawal is taken from visitor data provided by BLM, Forest Service, and NPS. Tables 3.17-25 and 3.17-26 summarize recreation visitor days (where available), per recreation site, located within and adjacent to the proposed withdrawal parcels. There are 23 recreation sites within the proposed withdrawal parcels; these include campsites, trailheads, scenic vistas, overlooks, etc. Values per visitor day are also included in the tables. An additional 17 sites are located in areas outside the proposed withdrawal parcels; these recreation sites were identified through consultation with BLM, Forest Service, and NPS staff.

Data presented and summarized in Tables 3.17-25 and 3.17-26 include valuation for recreation activities, estimated using the Travel Cost Method or Contingent Valuation Method. For a full discussion of both methods, see Loomis and Walsh (1997). Both recreation valuation methods have been used for over 30 years by federal agencies such as the USACE and U.S. Bureau of Reclamation (U.S. Water Resources Council 1979). The USFWS has also used these valuation methods since the 1980s.

Based on known visitor data and estimated value per visitor day, the annual benefit of recreation sites in and near the proposed North and E parcels is $6.3 million (see Table 3.17-25). Known visitor days are just over 81,000.

According to the known visitor data shown in Table 3.17-26, the annual benefit of recreation sites in and near the South Parcel is $444 million. Of the 4.7 million visitors counted, 94% were entering Grand Canyon National Park through the Grand Canyon Gateway. Ninety-nine percent of the South Study Area annual benefit can also be attributed to the gateway. Excluding the Grand Canyon, the estimated annual benefit of recreation sites in and near the South Parcel is about $5.1 million and known visitor days are about 280,000.

Table 3.17-25. Inventory of Recreation Sites in and Near the North Withdrawal Area

Proposed Withdrawal Parcel	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)	Recreation Activity	Value Per Visitor Day	Annual Benefits[h]
North	BLM	Hack Canyon	Trailhead	402	Hiking[f]	$43.91	$17,652
North	BLM	Swapp Trail	Trailhead	Not Available	Hiking[f]	$43.91	–
North	Forest Service	Gunsight Point	Overlook	Not Available	Sightseeing[d]	$18.07	–
North	Forest Service	Hatch Cabin	Cabin	Not Available	Sightseeing[d]	$18.07	–
North	BLM	Rock Canyon	Trailhead	Not Available	Hiking[f]	$43.91	–
East	Forest Service	House Rock Valley Overlook	Overlook	Not Available	Sightseeing[b]	$18.07	–
East	Forest Service	House Rock Overlook Interpretive Site	Interpretive Site	5,371	Interpretive[c]	$21.66	$116,335
East	BLM	Navajo Trail	Trailhead	Not Available	Hiking[d]	$43.91	–
East	BLM	Soap Creek	Trailhead	338	Hiking[f]	$43.91	$14,841
East	BLM	Rider Canyon	Trailhead	36	Hiking[f]	$43.91	$1,580
East	BLM	North Canyon Creek	Trailhead	36	Hiking[f]	$43.91	$1,580
East	BLM	Badger Creek	Trailhead	120	Hiking[f]	$43.91	$5,269
East	BLM	Dominquez-Escalante Interpretive Site	Historic site	10,635	Interpretive[e]	$21.66	$230,354.
East	BLM	Condor Interpretive Site	Wildlife/Overlook	4,200	Wildlife Viewing[e]	$69.42	$291,564
Outside Withdrawal Parcel	Forest Service	Snake Gultch	Trailhead	Not Available	Hiking[f]	$43.91	–
Outside Withdrawal Parcel	Forest Service	Saddle Mountain Wilderness	Wilderness Area	Not Available	Hiking[f]	$43.91	–
Outside Withdrawal Parcel	Forest Service/ NPS	South Canyon	Trailhead	54	Hiking[f]	$43.91	$2,371
Outside Withdrawal Parcel	NPS	Kanab Point	Overlook	16	Sightseeing[d]	$18.07	$289
Outside Withdrawal Parcel	NPS	150 Mile Canyon	Trailhead	Not Available	Hiking[f]	$43.91	–
Outside Withdrawal Parcel	NPS	SB Point	Overlook	Not Available	Sightseeing[d]	$18.07	–
Outside Withdrawal Parcel	NPS	Lees Ferry	Historic Site	Not Available	Interpretive[e]	$21.66	–
Outside Withdrawal Parcel	NPS	Point Sublime	Overlook	Not Available	Sightseeing[d]	$18.07	–
Outside Withdrawal Parcel	NPS	Swamp Point	Overlook/Picnic Area	Not Available	Picnicking[e]	$32.22	–
Outside Withdrawal Parcel	NPS	Tiyo Point	Overlook	Not Available	Sightseeing[d]	$18.07	–
Outside Withdrawal Parcel	NPS	Cape Royal	Overlook	Not Available	Sightseeing[d]	$18.07	–
Outside Withdrawal Parcel	NPS/BLM	Tuckup Point	Overlook	2	Sightseeing[d]	$18.07	$36

Table 3.17-25. Inventory of Recreation Sites in and Near the North Withdrawal Area (Continued)

Proposed Withdrawal Parcel	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)	Recreation Activity	Value Per Visitor Day	Annual Benefits[h]
Outside Withdrawal Parcel	BLM	Toroweap	Campground/ Overlook	3,859	Camping[g]	$20.87	$80,537
Outside Withdrawal Parcel	BLM	Vermilion Cliffs National Monument	National Monument	26,080[a]	General Recreation[g]	$99.34	$2,590,787
Outside Withdrawal Parcel	BLM	Grand Canyon Parashant National Monument	National Monument	29,674[a]	General Recreation[g]	$99.34	$2,947,815
Outside Withdrawal Parcel	BLM	Kanab Creek Wilderness	Wilderness Area	Not Available	Hiking[f]	$43.91	–
Outside Withdrawal Parcel	NPS	Bass Trail	Trailhead	243	Hiking[f]	$43.91	$10,670
North Withdrawal Area Total				**81,066**			**$6,311,680**

Sources: BLM (2010g); Forest Service (2009e); NPS (2009b).

[a] BLM (2009b) Arizona Strip Field Office Traffic Counts.

[b] Haspel and Johnson (1982).

[c] Loomis et al. (2005).

[d] Loomis (2005).

[e] Connelly and Brown (1988).

[f] Data from Brown et al. (1989); Richards and Brown (1992); Sublette (1975).

[g] Duffield et al. (2009).

[h] Annual benefit estimate included only when visitor counts are available.

Table 3.17-26. Inventory of Recreation Sites in and Near the South Withdrawal Area

Proposed Withdrawal Parcel	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)	Recreation Activity	Value Per Visitor Day	Annual Benefits[g]
South	Forest Service	Ten-X Family Campground	Family Campground	25,300[f]	Camping[c]	$20.87	$528,011
South	Forest Service	Charlie Tank Group Campground	Group Campground	3,500[f]	Camping[e]	$20.87	$73,045
South	Forest Service	Bike Trail	Trailhead	Not Available	Mountain Biking[e]	$210.26	–
South	Forest Service	Arizona Trail	Trailhead	Not Available	Hiking[f]	$43.91	–
South	Forest Service	Red Butte	Trailhead	Not Available	Hiking[f]	$43.91	–
South	Forest Service	Russell Tank Fishing Parking Area	Fishing Site	Not Available	Fishing[g]	$92.91	–
Outside Withdrawal Parcel	NPS	Camper Village	Campsite/Tent/ Trailer/ Recreational Vehicle	Not Available	Camping[h]	$20.87	–
Outside Withdrawal Parcel	NPS	Grand Canyon Gateway	Park Entrance	4,418,773	General Recreation[h]	$99.34	$438,960,909
Outside Withdrawal Parcel	NPS	Grandview Point	Overlook	Not Available	Sightseeing[d]	$18.07	–
Outside Withdrawal Parcel	NPS	Yaki Point	Overlook	250,088	Sightseeing[a]	$18.07	$4,519,090
South Withdrawal Area Total				**4,697,661**			**$444,081,055**

Sources: BLM (2010g); Forest Service (2009e); NPS (2009b).
[a] Loomis (2005).
[b] Connelly and Brown (1988).
[c] Data from Brown et al. (1989); Richards and Brown (1992); Sublette (1975).
[d] USFWS (2006b).
[e] Duffield et al. (2009).
[f] Annual estimates received from the Forest Service.
[g] Annual benefit estimate included only when visitor counts are available.

In terms of the annual benefit of each proposed withdrawal parcel, based on known data, the annual benefit of recreation in the North Parcel is $17,652. However, no visitor data are available for four recreation sites in this parcel. The estimated annual benefit in the South Parcel is $601,056. As with the North Parcel, visitor data are lacking for several sites in the parcel. The annual benefit of recreation in the East Parcel is $661,526; no visitor data are available for several recreation sites in this parcel.

In terms of the annual benefit of recreation sites based on agency ownership, recreation sites in the study area on BLM lands amount to an estimated $6.1 million; of this, $562,842 can be attributed to the withdrawal parcels, and the remainder can be attributed to recreation sites in the overall study area, outside the proposed withdrawal parcels. Recreation sites in the study area on NPS lands amount to an estimated $443 million; none of the NPS recreation sites are located within proposed withdrawal parcels. Forest Service visitor data are more limited; therefore, it is difficult to estimate the benefit of recreation sites on Forest Service lands. However, using the data that are available, Forest Service recreation sites in the study area contribute an estimated $719,763 each year.

HUNTING

Hunting is a popular activity within the study area; this activity occurs on both BLM and Forest Service lands. Large areas of undeveloped lands in northern Arizona provide habitat for many species, including big and small game. Big-game hunting use was estimated from AGFD data by game management unit (GMU), as this agency regulates the sport and records data on hunting use by animal and by area throughout Arizona. In Table 3.17-27, deer hunting was used as a proxy for estimating economic values from this activity in the study area.

Table 3.17-27. Big Game Hunting Use, Success Rate, and Economic Values in GMUs Overlapping the Proposed Withdrawal Areas (Averages 2004–2008)

AGFD GMU	Average Success Rate	Deer Average Annual Hunter Days	Elk Average Annual Hunter Days	$ Value/ Hunter Day	Annual Value for Each Entire GMU	% GMU in Study Area	Annual Value for % GMU in Study Area
9	29%	2,205	4,361	$81.00	$531,814	47.70%	$253,675
12A	59%	4,319	0	$165.76	$715,917	11.00%	$78,751
12B	69%	1,213	0	$192.00	$232,896	38.80%	$90,364
13A	74%	258	0	$204.00	$52,632	35.00%	$18,421
State Average	**45%**	**–**	**–**	**$125.00**			
Total					**$1,533,259**		**$441,211**

Sources: AGFD (2008b); USFWS (2006b).

Four GMUs in Arizona overlap the three proposed withdrawal parcels (GMU 9 in the South Study Area, and GMUs 12A, 12B, and 13A in the North Study Area). Based on available data for deer hunting, the value per hunter day is tailored to the hunting quality of each GMU, using the percent harvest success rate of the unit relative to the state average success rate. The state average value of hunting is $125 per day, according to USFWS (2006b). This statewide average value is associated with the statewide average success rate of 45%. Thus, GMU 9, with a success rate of 29%, has about two-thirds (64%) of the state average success rate. Using this ratio, the state average hunter day of $125 was adjusted downward for GMU 9 to reflect its lower success rate. Likewise, GMUs 12A, 12B, and 13A have higher success rates than the state average, so the implicit quality of the hunting trip would be higher than the state average, at $192 and $204, respectively. No data on the value per hunter day for elk hunting are available for Arizona. For this analysis, it was assumed that the value per hunter day for elk hunting is at least the same as for deer hunting.

Table 3.17-27 summarizes big-game hunting use, success rates, and values per day for each GMU in the study area. Based on the average success rates, average annual hunter days, and values per hunter day, the total estimated annual value is $1.53 million. The North Study Area (GMUs 12A, 12B, and 13A) accounts for approximately $1 million of this total value. The South Study Area (GMU 9) contributes the remaining $0.5 million. Hunting within the proposed withdrawal areas account for 29%, or about $440,000per year, of the economic benefit of hunting in these four GMUs.

EXISTENCE VALUE

Apart from the effects that visitor spending has on the regional economies in the area surrounding the Grand Canyon, and the benefits that visitors receive from recreating at the Grand Canyon, previous studies have documented that many people place a value simply on the existence of unique and pristine places like the Grand Canyon, whether they have ever visited it or not. Research indicates that existence value of a resource is most likely to be greater when the resource is unique (e.g., Grand Canyon National Park or Old Faithful Geyser in Yellowstone National Park) (Harpman et al. 1994).

A 1995 study estimated the existence value of the Grand Canyon at between $2.3 billion and $3.4 billion per year (Welsh et al. 1995). This study has not been updated, but presumably the effects of inflation and population growth continue to increase this value over time. This type of “existence value” is further demonstrated by the donations and funding received by environmental organizations dedicated to preserving places like the Grand Canyon.

ECOSYSTEM SERVICES

Grand Canyon National Park is not only a stunning natural wonder enjoyed by hundreds of thousands of tourists each year, it is also one of the largest areas of pristine wilderness in the Southwest (and in the lower 48 states). In its natural condition, the Canyon supports numerous species of flora and fauna, which are the subject of other parts of the EIS. The Colorado River is also one of the most important river systems in the United States and is heavily relied on by a large portion of the population of the Southwest for public drinking water, agricultural production, and other services.

While economists are beginning to develop tools to estimate the monetary value of some ecosystem services, at this time it is not possible to estimate the overall value of the ecological services provided by an area as complex as the Grand Canyon in monetary terms.

ECONOMIC ASPECTS OF ENVIRONMENTAL QUALITY AT GRAND CANYON NATIONAL PARK

The region’s visual quality is closely related to recreationists’ choices and levels of visitation. Two studies have looked at the value that visitors get from the current visibility conditions at Grand Canyon National Park (the Park is a Class I airshed) and how much they would pay to avoid a reduction in visibility.

One study (conducted by McFarland et al. in 1983) surveyed visitors at Grand Canyon National Park to estimate how much they would pay to avoid a reduction in visual range. This study found that the WTP was $2.64 per visitor day. A second study (by Brookshire and Schulze, also in 1983) asked households that visited Grand Canyon National Park what they would pay in higher daily park entrance fees to avoid a decrease in visibility from current conditions to poor conditions. These per-day visitor values ranged from $5.79 for visitors from Albuquerque, New Mexico, to $9.34 for visitors from Los Angeles, California. These values and references are summarized in Table 3.17-28. These values reflect adjustment using the Consumer Price Index from the original study year dollars to 2010 dollars.

In addition to these WTP values, the McFarland et al. (1983) study also asked whether visitors would change their length of stay at Grand Canyon National Park as a result of deterioration of visual range or visibility. About 80% of visitors said they would shorten their length of stay at the Park. A reduction in visitation would have the effect of reducing visitor spending, thereby changing impacts of recreation on the regional economy.

Table 3.17-28. Summary of Values to Visitor to Prevent a Decrease in Visibility (Visual Range) at Grand Canyon National Park

Study	Sample	WTP per Visitor Day ($2010)
McFarland et al. (1983)	On-site visitors	$2.64
Brookshire and Schulze (1983)		
Albuquerque, New Mexico	Visiting households	$5.79
Denver, Colorado	Visiting households	$6.69
Los Angeles, California	Visiting households	$9.34

Sources: Brookshire and Schulze (1983); McFarland et al. (1983).

This previous research demonstrates visitor sensitivity to changes in environmental quality at the Grand Canyon. No studies have been identified that examined visitor responses to changes in water quality, soundscape quality, or other environmental attributes of the area, but it is possible that changes in other environmental attributes of the Grand Canyon could also have quantifiable effects.

Energy Resources

The major mining commodity of interest in the proposed withdrawal area is uranium. Other precious metals could be recovered from breccia pipe deposits concurrent with uranium mining, including gold, silver, copper, and vanadium. However, recovery of these metals is assumed to not be significant enough to drive mine development and thus is not considered in this study as part of the mineral economics discussion (see Appendix B).

RESERVES AND RESOURCES

Northern Arizona is known to be an area with high potential for uranium mining. Not only have reserves been confirmed through drilling, but the USGS (Finch et al. 1990) has also estimated the undiscovered uranium endowment to have a mean value of about 1.3 million short tons (2.6 billion pounds) U_3O_8. A more recent USGS report (Otton and Van Gosen 2010) states that the proposed withdrawal parcels are estimated to contain 12% of the estimated undiscovered endowment. The estimate of undiscovered endowment comprises all mineralized material containing at least 0.01% U_3O_8 and no consideration is made whether any or all of this material could be economic to mine. As discussed in the RFD (see Appendix B), for the purposes of this analysis it was assumed that 15% of the undiscovered endowment would be mined. The total mean undiscovered endowment in the withdrawal area is 163,380 short tons (326.8 million pounds) U_3O_8, of which 24,508 short tons (49 million pounds) U_3O_8 is considered mineable. In addition to this mineable portion of the undiscovered uranium resource, there are 15,158 short tons (30.3 million pounds) U_3O_8 of known uranium reserves in the withdrawal parcels.

Known reserves, the portion of undiscovered endowment assumed to be economic to mine, and total estimated undiscovered endowment can be compared with global and national reserves and estimates to total U.S. endowment. There have been no estimates made of global undiscovered uranium endowment. Total estimated reserves and resources for the withdrawal area are 178,538 short tons (357 million pounds) U_3O_8 of which 39,666 short tons (79.3 million pounds) are estimated to be economic to mine. The Energy Information Administration (EIA) reports uranium reserves and resources in the United States in two forward-cost categories of $50 or less and $100 or less per pound U_3O_8 (Table 3.17-29).

Table 3.17-29. Uranium Reserves and Resources in the United States, Year-End 2008 (in million pounds U_3O_8)

Category	Forward-Cost Category ($ per pound) $50 or less	Forward-Cost Category ($ per pound) $100 or less
Reserves	539	1,227
Estimated Additional Resources	3,310	4,850
Speculative Resources	2,230	3,480
Total	**6,079**	**9,557**

Source: EIA (2010b).

Forward-costs are future expenditures that would be required produce uranium from undeveloped reserves and resources, including development costs. Some or all of undiscovered endowment estimated by the USGS for Northern Arizona and other regions of the United States are included in the category of speculative resources, depending on estimated development and production costs. The USGS estimate for undiscovered endowment is not based on economic criteria, thus the figure for total estimated uranium reserves and resources for the United States that best compares with the estimate of reserves and resources for the withdrawal area is the total at a forward-cost of $100 or less per pound U_3O_8. The OECD Nuclear Energy Agency (2010) reports reasonably assured and inferred global uranium "resources" at a price of $130 per kilogram uranium (about $70 per pound U_3O_8) of 14 billion pounds U_3O_8. This figure is not directly comparable to the either of the EIA forward-cost categories and comprises the EIA reserves and part of the EIA estimated additional resources categories but can be assumed to broadly represent world reserves. There are no global estimates for speculative resources (Table 3.17-30).

Table 3.17-30. Comparison of World, United States, and Withdrawal Area Reserves and Resources of Uranium, Year-End 2008 (in million pounds U_3O_8)

Category	Withdrawal Area	United States	World
Reserves	79[a]	1,227	14,000[c]
Estimated Additional Resources		4,850	
Speculative Resources	278[b]	3,480	
Total	**357**	**9,557**	

Source: EIA (2010b)

[a] Known reserves plus 15% of undiscovered endowment.

[b] Balance of undiscovered endowment.

[c] Includes indicated resources.

From Table 3.17-29, estimated total reserves for the withdrawal area, including 15% of estimated endowment, are about 6% of U.S. reserves and 0.6% of world reserves. Total estimated uranium endowment for the withdrawal area is about 4% of national estimated resource endowment.

The World Nuclear Association (2010a) reports uranium production in 2010 for the largest 30 uranium mines in the world. These mines collectively account for 74% of world production. Mines with sufficient reserves to produce at the rates of these mines are highly important to world uranium supply. The 10 largest mines, accounting for 55% of world uranium production, operated in 2010 at rates ranging from 4 to 20 million pounds U_3O_8 per year. The next 20 largest mines, accounting for 19% of world uranium production, operated in 2010 at rates ranging from 1.5 to 4 million pounds U_3O_8 per year. Although individual breccia pipe uranium deposits in Northern Arizona are too small operate at a capacity as large as 1.5 million pounds U_3O_8 per year, Alternative A forecasts a collective annual production of about 4 million pounds U_3O_8 per year from about 6 mines.

DEMAND AND POTENTIAL FUTURE PRODUCTION

Forecast production from the withdrawal area under Alternative A is about 4 million pounds U_3O_8 per year. This compares with total United States production of uranium in 2010 of 4.2 million pounds U_3O_8 (EIA 2011b). Over the past 20 years U.S. production has averaged 4.4 million pounds U_3O_8 per year but during the 1960s to 1980s, production averaged about 28 million pounds U_3O_8 per year (EIA 2011b).

In 2010, U.S. nuclear power plants purchased 47 million pounds of U_3O_8 equivalent, of which 92% was imported and 8% was of U.S. origin (EIA 2011b). U.S. production of uranium in 2010 was equivalent to 9% of U.S. demand. Domestic demand is generally forecast to rise over the next decade, fluctuating between 46 and 56 million pounds U_3O_8 per year through 2020 (EIA 2010c). Global uranium demand is also expected to rise, with a forecast increase of 33% between 2010 and 2020 and 16% from 2020 to 2030 (World Nuclear Association 2010b).

Road Condition and Maintenance

Access routes to the proposed withdrawal area along with average daily traffic volume are discussed in Section 3.16.1 under Transportation Conflicts. On BLM lands on the Arizona Strip, paved roads are rare and account for less than 3% of the transportation system (including roads, primitive roads, and trails) (BLM 2008b). Of the total transportation system (8,032 miles), 6,675 miles (84.5%) consist of primary, secondary, and tertiary unpaved roads. Various federal, state, and/or county agencies and private groups or individuals maintain these roads. The road network provides access to area destinations, including mining and livestock operations, utility and communication facilities, and range and wildlife developments, etc. (BLM 2008b). The road network is also valuable to the recreating public for access.

In terms of Forest Service lands, nationally, most of the existing roads on Forest Service lands were built over the past 50 years for harvesting timber. As with BLM roads, forest roads provide access for recreation, research, fish and wildlife habitat management, grazing, resource extraction, fire protection, insect and disease control, and private land use, among other things. A revised travel management rule is currently being developed for the Tusayan Ranger District. Under the selected alternative for the new travel management rule, there will be 566 miles of roads open for public use in the district and 143 additional miles of roads to be used only for administrative purposes (Forest Service 2011).

The BLM Arizona Strip Field Office is currently revising its route designations through a separate NEPA process. These route designations will likely result in changes to the existing route network and mileages discussed above.

After using unpaved roads on federal lands in proximity to potential future uranium mines, ore haulers taking uranium ore to the White Mesa Mill in Blanding may next make use of county roads before ultimately travelling on state and federal highways for most of the travel distance to the mill. County roads are maintained by Coconino County and Mojave County (depending on their location), primarily using funds obtained from State of Arizona distributions of Highway User Revenue Funds (which are in turn generated primarily by fuel taxes and vehicle licensing fees). Coconino County spent $19.4 million on road maintenance and construction in FY2010, about $6.3 million more than it received in revenues to fund such operations (Coconino County 2010). Mohave County spent $22.4 million for road construction and maintenance in 2010, about $10.3 million more than it received in revenues to fund highway and road operations (Mohave County 2010b).

The Arizona and Utah Departments of Transportation (ADOT and UDOT) would be responsible for managing and funding maintenance on state highways. ADOT budgeted $94 million for road maintenance in FY2010, a 28% decrease from FY2008 due to revenue shortages (ADOT 2009a). UDOT maintains over 5,800 miles of highways and expended approximately $136 million for state highway maintenance in FY2010 (Utah State Legislature 2011).

3.17.3 Economic Condition Indicators

Mineral exploration and construction, operation, and maintenance of uranium mine facilities and/or the proposed withdrawal of mineral estates and the associated reduction in future mineral exploration and development have the potential to impact economic conditions within the study area. Resource condition indicators include those listed below (Table 3.17-31).

Table 3.17-31. Economic Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Effects on economic activity related to mineral development	Future mining activity in the proposed withdrawal areas would be directly affected by the alternatives. This could lead to changes in future economic conditions.	*Indicator:* Direct and indirect changes in output, value-added, employment and earnings due to changes in mining activity. *Indicator:* Changes in state and local government revenues due to changes in mining activity.
Road condition and maintenance	The use of road systems to service mine operations could require increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access.	*Indicator:* Number of haul trips anticipated on major public use roads over the next 20 years relative to existing usage levels.
Effects on economic activity from tourism	The public lands in the study area are a key component of regional tourism and the tourism-related economy. If the alternatives lead to changes in visitation, there would be impacts on future economic conditions.	*Indicator:* Visitor user days and value per visitor user days to tourist destinations, primarily Grand Canyon National Park but also National Forest System and BLM lands.
Effects on existence values and value of ecosystem services	Prior studies indicate the public places a large value on maintaining environmental quality at Grand Canyon National Park. The Park also provides important ecological services such as providing habitat for numerous species and protecting water quality in the Colorado River.	*Indicator:* Environmental conditions at Grand Canyon National Park.
Energy resources available	The withdrawal of uranium deposits in the study area would remove a potential source of U.S. uranium production for use in generating electricity.	*Indicator:* Change in uranium production from the study area relative to overall U.S. and global production.

Economic Activity

Economic activity can be described in terms of various metrics, including output, value added, employment, and employee compensation. IMPLAN 2009 software and data will be used to model potential changes in economic activity under the alternatives, reflecting different levels of future mining activity based on the RFD (see Appendix B). Should the alternatives be determined to have quantifiable effects on tourist activity, these effects can also be modeled with IMPLAN. The IMPLAN modeling system captures direct, indirect, and induced economic effects (multiplier effects).

Taxes and Revenues

Indicators used to determine the economic conditions in the study area include state and local revenues potentially affected by the alternatives, including severance taxes in Arizona, state personal and corporate income taxes in Arizona and Utah, and sales-related tax revenues for both state and local governments.

IMPLAN 2009 software and data will be used to model potential changes in taxes, except for Arizona severance tax revenues which will be modeled based on IMPLAN estimates of the taxable value of mining activity under each alternative and the current severance tax code in Arizona.

Road Condition and Maintenance

Indicators used to determine conditions regarding road condition and maintenance include the number of haul trips for existing mines over the next 20 years and potential effects on future maintenance requirements.

Recreation and Environmental Economics

Indicators used to determine the economic conditions in the study area with respect to recreation economic and environmental quality include the tourist visits, expenditures and corresponding economic activity; recreation visitor days and the estimated economic benefit of non-consumptive and consumptive recreation activities; and the environmental attributes of Grand Canyon National Park.

Effects on the tourism-related economy and benefits to recreationists will be evaluated by considering the potential for changes in visitation or visitor values per day based upon the recreation resource analysis. Monetary effects on existence values or ecological services related to Grand Canyon National Park cannot be quantified based on available information.

Energy Resources

Indicators used to determine conditions regarding the availability of energy resources include the amount of mineable undiscovered uranium resources and uranium reserves within the proposed withdrawal areas and the magnitude of these resources relative to other domestic and international uranium reserves, as well as domestic and international demand.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Implementation of any one of the alternatives described in Chapter 2, Proposed Action and Alternatives, may result in direct or indirect changes to the human and physical/natural environment in and around the proposed withdrawal area. Actions associated with any of the alternatives may also contribute to impacts associated with other past, present, or reasonably foreseeable future actions in and around the area. This EIS assesses and analyzes these potential changes and discloses the impacts, as well as the significance of these impacts, to the decision-maker and the public. This process of full disclosure is one of the fundamental aims of NEPA.

This chapter is organized by resource as described in Chapter 3, Affected Environment, and is divided into assessments, by alternative, of the following resources: air quality and climate; geology and mineral resources; water resources; soil resources; biological resources, including vegetation, wildlife, and special status species; visual resources; soundscapes; cultural resources; American Indian resources; wilderness resources; recreation resources; and social and economic conditions, including environmental justice and public health and safety. Impacts specific to the mining exploration and development anticipated to take place under a given alternative are described as changes in resource condition with respect to the resource indicators identified in Chapter 3.

Impacts to these resources were determined using both quantitative and qualitative approaches. Impacts were considered within specific temporal and spatial boundaries established for each resource, as described in Chapter 3, and the analysis included consideration of the crossing of administrative boundaries. The potential for simultaneous or related impacts to more than one resource was also considered in the analysis, as was the potential under any alternative for impacts to be beneficial as well as adverse.

4.1.1 Foreseeable Activity Assumptions

In order to complete a meaningful impacts assessment, it was necessary to generate RFD scenarios of anticipated mining-related exploration and development within the proposed withdrawal area. This analysis is included in Appendix B. The purpose of the RFD scenarios is to provide a prediction of the level and type of reasonably foreseeable future locatable mineral exploration and development and thereby provide a common set of assumptions across all resources and alternatives.

In developing the RFD, the life cycle of a mine was assumed to be 7 years. This was determined from a review of existing and recent locatable mining activity and includes initial permitting, development, production, and reclamation. This time period does not include uncertainty factors, such as delays in permitting, size of the ore body, or periods of temporary closure where operations are being conducted pursuant to the interim management plan in the mine’s approved plan of operations. In the context of the RFD, “reclamation” refers to backfilling waste rock into the mine, sealing the mine to re-establish hydraulic gradients and prevent mine drainage, dismantling and removing infrastructure or equipment, and initially revegetating the mine site and haul roads.

The following assumptions were made in developing the RFD scenarios:

- While other precious and rare earth metals could be recovered from breccia pipe deposits concurrent with uranium mining, including gold, silver, copper, and vanadium, in accordance with the BLM mineral potential report for the proposed withdrawal (BLM 2010a), the values from recovery of these metals are assumed to not be sufficient to drive mine development.
- There are 45 confirmed breccia pipes within the proposed withdrawal area; potential future mining activity would be associated with these pipes as well as undiscovered uranium reserves. Based on the findings of the 2010 USGS estimate of undiscovered uranium resources, the RFD estimates that 16 mines would be required to extract that reserve (see the RFD, Appendix B:B-22).
- Four of these confirmed breccia pipes are associated with approved mining plans of operation (Arizona 1, Kanab North, Pinenut, and Canyon). These breccia pipes are assumed to be mined under all alternatives. An additional seven breccia pipes have adequate information to estimate uranium reserves, and these breccia pipes are also assumed to be mined under all alternatives. Development of all other breccia pipes, discovered or undiscovered, varies depending on the alternative.
- The active life of a typical uranium mining operation is assumed to be 7 years and includes four phases: initial permitting and planning (2 years), physical development of the mine (1 year), production (3 years), and reclamation (1 year). A maximum of six mines would be in production at any given time.
- Based on historic data, approximately 28 exploration projects are expected to take place for every mine expected to be developed, with each exploration project requiring five drill holes and temporarily disturbing 1.1 acres.
- Mining a typical breccia pipe would result in the removal of 278,000 tons of ore and yield 3 million pounds of the uranium compound U_3O_8 (1,500 tons U_3O_8) at an ore grade of 0.54%. Removal of this quantity of ore would require 11,120 haul trips of 25 tons each.
- Each mine expected to be developed has a surface disturbance of approximately 20 acres, with each mile of access/haul road disturbing 2.42 acres/mile and each mile of power line disturbing 0.17 acre/mile.
- Each mine would drill a production well into the R-aquifer and would use an average of 5 gpm during development and production, or approximately 10.5 mgal over the life of the mine.

4.1.2 Impact Assessment Methodology and Definitions

This chapter analyzes both beneficial and adverse impacts that would result from implementing any of the alternatives considered in this EIS. This chapter also includes definitions of impact thresholds for each resource, methods used to analyze impacts, and the analysis methods used for determining cumulative impacts. Table 4.1-1 provides standard definitions of degree and duration of impact that are broadly applicable to all resources; certain analyses in the sections that follow have further refined these definitions to be more specific to that particular resource. A summary of the environmental consequences for each alternative is provided in Table 2.8-1, which can be found in Chapter 2.

For ease of reading, the impacts of mineral exploration and development activities on a specific resource under a particular alternative are generally characterized as no impact, minor, moderate, or major. This represents comparison to the status quo or baseline for that resource. However, in order to properly and meaningfully evaluate the impacts of each withdrawal alternative, the impacts expected from mining under that alternative should be measured against the impacts projected to occur under Alternative A, which is the baseline for purposes of comparison of the alternatives to one another, as it represents the amount of reasonably foreseeable mineral development should no withdrawal take place. That is, the true impact of a particular action alternative is the difference between the impacts under Alternative A and that particular alternative.

Table 4.1-1. Standard Resources Impact Description

	Description Relative to Resource
Magnitude	
No Impact	Would not produce obvious changes in baseline condition of the resources.
Minor	Impacts would occur, but resources would retain existing character and overall baseline conditions.
Moderate	Impacts would occur, but resources would partially retain existing character. Some baseline conditions would remain unchanged.
Major	Impacts would occur that would create a high degree of change within the existing resource character and overall condition of resources.
Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

The following section defines and clarifies the concepts and terms used in this EIS when discussing the impacts assessment. The terms “impact” and “effect” are used synonymously.

Impacts

Impacts may refer to ecological, economic, aesthetic, historical, cultural, social, or health-related phenomena that may be caused by implementation of the Proposed Action or any of the other alternatives. Impacts, both beneficial and detrimental, may be direct, indirect, or cumulative.

Direct Impacts

A direct impact is an effect on a resource that is caused by the action and occurs at the same time and place.

Indirect Impacts

An indirect impact is a reasonably foreseeable effect that would occur later in time or be separated by some distance from the action while remaining consistent with the temporal and spatial boundaries of analysis established for the resource.

Cumulative Impacts

A cumulative impact is a project-induced impact that, when added to the effects of other past, present, and reasonably foreseeable future actions, results in an incremental effect on the resource. Individually minor actions can become collectively more significant taking place over a period of time.

Note that the temporal and spatial bounds for cumulative impacts assessment may be substantially larger than those for a direct impacts assessment.

Residual Impacts

Impacts are considered residual when the effect from the proposed project cannot be completely avoided or minimized and remains after or despite mitigation.

Significance

Significance has a very particular meaning when used in a NEPA document. Significance is defined by CEQ [40 CFR 1508.27] as a measure of the *context* and *intensity* of the impacts of a major federal action on, or the importance of that action to, the human environment.

Intensity refers to the severity or level of magnitude of impact. Proximity to sensitive areas or protected resources, public health and safety, level of controversy, unique risks, or potentially precedent-setting results are all factors considered in determining the intensity of the effect.

Context means that the effect(s) of an action must be analyzed within a framework or within physical or conceptual limits. Resource disciplines, location, type, or size of area affected (e.g., local, regional, national), and affected interests are all elements of context that ultimately determine significance. Both short- and long-term impacts are relevant.

Impact Indicators

Use of the term *significant* when referring to resource impacts indicates that some threshold was exceeded for a particular impact indicator. Impact indicators are the consistent parameters used to determine quality, intensity, and duration of change in a resource. Working from an established existing condition (i.e., the baseline conditions described in Chapter 3), one or more condition indicators are used to predict or detect change in a resource related to causal impacts of proposed actions. These thresholds are consistent with CEQ's guidance on the criteria for a significant impact. Table 3.1-1 in Chapter 3 lists the key issues for analysis in this EIS, as derived from public scoping and agency input, and the corresponding resource condition indicators that were used in the impact analyses described in this chapter.

4.2 AIR QUALITY AND CLIMATE

4.2.1 Introduction

This section analyzes the potential changes in air pollutant emissions created by each alternative being evaluated for this EIS. The air resources analysis addresses potential changes on attainment of the NAAQS, HAP emissions, and AQRVs or the triggering of conformity analysis with respect to an individual or combined uranium mines (i.e., PSD/New Source Review [NSR]).

It is important to note that the comparison of the air quality impacts to the NAAQS and AQRVs was made using screening level modeling. Air pollutant dispersion concentrations for the comparison of the NAAQS were derived from existing mine operations (i.e., the Arizona 1 Mine). Visibility was determined using a screening model and the emissions associated with air pollutant emissions under each alternative. Refined dispersion or visibility modeling was not conducted. Individual mines or development of such mines were considered point sources for the purpose of determining an exceedance of the significance thresholds for PSD/NSR. It should be noted that when considering significance thresholds for PSD/NSR fugitive particulates and tailpipe emissions (i.e., mobile sources) are not quantified. Only those particulates or other criteria pollutants associated with point sources are quantified when evaluating significance. However, these emissions have been quantified for the purposes of NEPA only for informational purposes as the NEPA air quality analysis is not a PSD increment consumption analysis.

The majority of the impacts discussed in the following sections pertain to the following four underground mine life cycle stages: 1) exploration, 2) mine site development, 3) actual production operations, and 4) reclamation. Within each of these stages, the following construction, although temporary in nature, and operational emission sources, are considered:

- Exploration Activities
    - Criteria air pollutant and GHG tailpipe emissions from vehicles and equipment;
    - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from vehicles and equipment traveling on paved and unpaved roads, and;
    - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from earth-moving activities and exploratory drill holes.
- Mine Development
    - Criteria air pollutant and GHG tailpipe emissions from construction vehicles, equipment, and worker commuting associated with the development of the mine site and construction of new access roads and power lines;
    - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from construction and worker commuting vehicles traveling on paved and unpaved roads, and;
    - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from earth-moving activities.
- Mining Operations
    - Criteria air pollutant and GHG tailpipe emissions from vehicles, equipment, and worker commuting associated with the operation of the mine;
    - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from equipment and worker commuting vehicles traveling on paved and unpaved roads;
    - Point and fugitive emissions associated with the mining equipment, material handling sources, storage piles, and fuel storage tanks, and;
    - Radon gas emissions associated with the operation of the mine.
- Mine Closure and Reclamation
    - Criteria air pollutant and GHG tailpipe emissions from reclamation vehicles and equipment;
    - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from reclamation vehicles and equipment traveling on paved and unpaved roads, and;
    - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from earth-moving activities associated with reclamation.

For purposes of this air quality impact analysis, a “typical” 300 ton per day (tpd) breccia pipe mine from exploration to reclamation was evaluated. Based on Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios, it is anticipated that a maximum of six mines would be operated at any one time in the North, East, and South parcels. It was also assumed that each mine would be in production (i.e., “mine operations” stage) for no more than 3 years with a 7-year life cycle (i.e., exploration through reclamation). In most instances, impacts are categorized and described in general terms without reference to a particular mining facility type or any site-specific resources. This “typical” mine’s predicted emissions are then multiplied by the number of proposed exploration sites, mine sites, and number of miles of new access roads and power lines as presented in Table 2.7-3, Reasonably Foreseeable Future Locatable Mineral Operations by Alternative (anticipated over 20 years). Analysis of the number of existing and proposed exploration sites, mine site, miles of new access roads, miles of new power lines, and number of ore haul trips required for each of the alternatives presented in Chapter 2 was conducted.

Proposals for mining operations continue to be processed by the BLM and the federal land managers in the proposed withdrawal area. Mining operations would be required to obtain an air quality permit from the ADEQ. For the purposes of the impacts analysis, the Arizona 1 Mine was assumed to be representative of a “typical” mining operation in the proposed withdrawal area.

This assessment assumes there would be no processing (physical or chemical) of the uranium ore at the actual mine site or within the proposed withdrawal area. All ore mined within the proposed withdrawal area is assumed to be hauled from the mine site to the White Mesa Mill, located in Blanding, Utah.

4.2.2 Incomplete or Unavailable Information

Refined dispersion or visibility modeling was not conducted for this EIS. $PM_{2.5}$ modeling results were not available and were not included in the Arizona 1 Mine Air Permit Application, dated April 2008. The type of analysis required to determine the impact from all potential sources is beyond the scope of this analysis. Such modeling is required to estimate potential impacts to the air quality study area. Furthermore, there is currently no standard methodology or model to determine how an individual source’s or project’s GHG emissions would translate into physical impacts to the local or global environment.

A valid analysis of potential air quality impacts associated with any of the alternatives cannot be made without descriptions of each of the individual proposed exploration and mine sites, including precise location (topography), atmospheric conditions, roster of equipment, number of mine shafts, ore production rates, etc. Without knowledge of the specific location of each air pollutant source, these variables cannot be considered.

This EIS is framed as an overarching review for a very large area included in the three proposed withdrawal parcels encompassing numerous proposed exploration and mine sites. If a future mine is proposed, a separate environmental analysis for that specific mine would be performed at a level of detail appropriate for that site.

4.2.3 Impact Assessment Methodology and Assumptions Pertaining to all Alternatives

For the purposes of air quality impact analysis, the following terms were used to describe the potential impact and duration of impact on air quality (Tables 4.2-1 and 4.2-2).

Table 4.2-1. Magnitude and Degrees of Effects on Air Quality

Attribute of Effect	Description Relative to Air Quality
Magnitude	
No Impact	Would not produce obvious changes in baseline condition of the resources.
Minor	Impacts would occur, but resources would retain existing character and overall baseline conditions.
Moderate	Impacts would occur, but resources would partially retain existing character. Some baseline conditions would remain unchanged.
Major	Impacts would occur that would create a high degree of change within the existing resource character and overall condition of resources.

Table 4.2-2. Duration Definition of Effects on Air Quality

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

Source: UDEQ (2005).

The Proposed Action deals specifically with the withdrawal of federal lands from future location and entry under the Mining Law. The withdrawal of these lands from future location of new claims would likely have little effect on the worldwide generation of power but could have a negative effect on America's ability to generate clean power. Uranium mining activities in the proposed withdrawal will likely cause localized increases in air pollutant emissions, with the exception of GHG emissions, which are considered by scientists to contribute to global climate change and which could have global impacts.

To assess the current value of the air quality resource condition indicators, measurement of existing background air pollutant concentrations, topography, and meteorological data in the specific area of any potential mine sites would be needed. Once the proposed mine site background air pollutant concentrations, site-specific topographic and meteorological data, and sufficient details regarding the exploration, mine development, operations, and closure/reclamation are accurately established, air modeling could be carried out. The results of the modeling would allow for a quantitative estimate of possible air pollution effects of each proposed mining operation. Without specific knowledge of the location of potential mine sites or how the mine operations will be carried out (e.g., number of shafts, ore production rate, specific types of equipment, etc.), no realistic conclusions can be drawn with regard to the possible air quality effects of their operation on Grand Canyon National Park.

Potential impacts of the proposed withdrawal alternative and the other alternatives on ambient air quality were assessed by first quantifying emissions for a "typical" 300-tpd breccia pipe uranium mine, including exploration through mine closure and reclamation activities (Denison 2010a). Emissions were calculated using ADEQ and EPA agency-accepted emission factors (EFs) and conservative engineering assumptions, as needed. Tables 4.2-2 and 4.2-3 provide definitions of impact magnitude and duration, respectively, as they relate to Air Quality and Climate.

These emission rates were then input to EPA's VISCREEN model (Version 1.01), following guidance in the EPA Workbook for Plume Visual Impact Screening and Analysis (Revised), October 1992, EPA-454/R-92-02 (EPA 1992). Sources of air pollution can cause visible plumes if emissions of particulates and NO_x are sufficiently large. The plume will be visible if the pollutant constituents scatter or absorb sufficient light to make the plume brighter or darker than its viewing background (e.g., the sky or terrain feature). PSD Class I areas such as national parks and wilderness areas are afforded special visibility protection designed to prevent such plume visual impacts to observers within a Class I area (EPA 1992).

VISCREEN was used to ascertain whether the emissions from the facility have the potential to be perceptible to untrained observers under "reasonable worst case" conditions. These VISCREEN results were compared with the criteria established in EPA (1992) for maximum visual impacts inside Grand Canyon National Park.

First, the methods used to estimate emissions are described, including exploration, mine site development, ore mining operations, and finally mine closure and reclamation. Next, the modeling analyses used for the impact assessment related to the visible plume are described.

Exploration Activities

The initial exploration activities would include mobilization of a drill rig and support vehicles to a potential mine site for the drilling of exploratory drill holes. Sources of air pollutant emissions during the exploration activities include both particulate matter emissions and fuel-combustion emissions. For the purposes of estimating emissions, each exploration site was estimated to disturb approximately 1.1 acres and would involve boring five exploratory drill holes (BLM 1990). Based on Goldenseal Construction Estimating Software, the anticipated duration for the exploratory activities was assumed to require 30 working days (1.5 months) per exploration site.

Exploration activities generally would be scheduled during daylight hours (8:00 a.m.–5:00 p.m.), Monday through Friday. In actuality, the project duration may last longer than the number of days estimated above because of unfavorable weather conditions and holidays. However, these non-working days do not affect the emission estimates calculated here.

Mine Development

Activities included in development of the mine are the construction of access roads, installation of power lines, site preparation for the fixed facilities (e.g., office complex, shop/warehouse hoist house, fuel storage tanks, standby generator, screener, and mine shaft exhaust fans), delivery of materials and equipment to the mine, and other construction vehicle activity. Sources of air pollutant emissions during the mine development activities include both particulate matter emissions and fuel-combustion emissions. As described in Chapter 2, each development site was estimated to disturb approximately 20 acres, and varied lengths of new access roads and power lines would be installed for each withdrawal parcel, depending on the alternative. It was assumed the power lines would be constructed using 40-foot-long wooden poles, spaced 300 feet apart, requiring approximately 18 poles per mile.

The anticipated duration for the development of the mine site was assumed to require 40 working days (2 months), and it was assumed that 5 working days would be required per mile of new access road or power line to be installed. Mine development activities generally would be scheduled during daylight hours (8:00 a.m.–5:00 p.m.), Monday through Friday. In actuality, the project duration may last longer than the number of days estimated above because of unfavorable weather conditions and holidays. However, these non-working days would not affect the emission estimates calculated here. The individual mine development schedules are based on typical construction activities in rural locations.

Mine Operations

Sources of pollutant emissions during the operation of the mines include particulate matter emissions and fuel-combustion emissions. Both on- and off-site mining activities were considered. Based on Chapter 2, each mine would have a uranium production life of 3 years. The following particulate matter emissions associated with the mining activities (fugitive dust) were evaluated:

- Vehicle and equipment traffic on improved and unimproved dirt roads as well as paved roads (worker vehicles, water trucks, heavy-duty diesel trucks, and ore haul trucks).
- Topsoil and waste rock handling and storage (front-end loaders and trucks).
- Uranium ore loading, unloading, hauling, and storage (front-end loaders and trucks).
- Wind erosion of storage piles, and
- Underground mining operations.

Dust suppression procedures such as routine watering were considered in the emission inventory calculations.

The following fuel-combustion emissions associated with the mining activities (tailpipe exhaust) were evaluated:

- Mobilization of vehicle and equipment to the mine site (worker vehicles, water trucks, heavy-duty diesel trucks, and ore haul trucks).
- On-site equipment operation (standby generator, front-end loaders, and haul trucks).

Mine Closure and Reclamation

Once the mining activities have ceased, the impacted land is required to be reclaimed. Reclamation activities include backfilling the waste rock into the mine, sealing the mine, removing the infrastructure and equipment, and revegetating the mine site. Emissions were quantified for the closure/reclamation of the mine, which include fugitive dust generated during earth-moving activities (e.g., waste rock backfilling, site grading, and revegetation) and fuel-combustion (vehicle and equipment tailpipe emissions). As described in Chapter 2, each development site was estimated to disturb approximately 20 acres. Based on Goldenseal Construction Estimating Software, the anticipated duration for the closure and reclamation of the mine site was assumed to require 20 working days (1 month) of surface disturbance–related activities.

Mine closure/reclamation activities generally would be scheduled during daylight hours (8:00 a.m.–5:00 p.m.), Monday through Friday. In actuality, the project duration may last longer than the number of days estimated above because of unfavorable weather conditions and holidays. However, these non-working days do not affect the emission estimates calculated here.

Surface Disturbance Emissions

During exploration, development, and operation of the mine fugitive dust emissions associated with surface disturbances (e.g., exploratory drilling, site development, and other earth-moving activities) would be generated. Fugitive dust emissions were quantified for each category using the specified timeline, number of acres disturbed, and reasonable assumptions. It was assumed that the entire surface of the 1.1-acre exploration site and 20-acre mine site would be disturbed and that the access roads would be 14 feet wide. Power lines were assumed to parallel the access roads and to not require construction of a separate access road. In reality, power lines deviate to take the most direct route; therefore, the actual miles of power lines to be installed would likely be less.

There are numerous ways to estimate fugitive dust emissions from construction activities. However, the level of precision depends on the availability and accuracy of project-specific data such as silt content of excavated soil, soil moisture content, depth of excavation, wind speed, annual precipitation, type of construction equipment used, distance traveled, and the frequency and magnitude of water or surfactants application to control dust on unpaved roads and in the excavation areas.

Because of the lack of data, fugitive dust emissions associated with exploration operations were quantified using fugitive dust emission factors available on the California Air Resources Board (CARB) webpage[10] (CARB 2003). The emission factor, 0.11 ton of PM_{10} per acre-month, was developed to analyze PM_{10} emissions generated from average construction operations that do not involve substantial earth-moving activities. This emission factor assumes that water is applied during operations to minimize fugitive dust, resulting in an emission reduction efficiency of 50%. Substantial earth-moving operations

[10] Available at: <http://www.arb.ca.gov/ei/areasrc/ONEHTM/ONE7-7.HTM>.

are defined as any earth-moving operation with a daily volume of 5,000 cubic yards or more that occurs three times during a 365-day period (CARB 2003). Since only the surface would be disturbed as a result of vehicle and equipment traveling from each of the drill hole sites and the limited number of exploratory borings, the exploration activities are considered to be an average, typical construction operation, as defined by CARB.

To estimate $PM_{2.5}$ emissions from combustion and fugitive sources, South Coast Air Quality Management District (SCAQMD) created a method to estimate $PM_{2.5}$ emissions from combustion and mechanical/fugitive emission sources. Mechanical sources are any type of sources other than combustion (in this case, fugitive dust generated from motor vehicles traveling on unpaved roads). The method assumes a direct correlation between PM_{10} and $PM_{2.5}$ data in the 2003 air quality management plan (AQMP) annual inventories for combustion and mechanical/fugitive sources, SCAQMD-derived default ratios for mechanical/fugitive process, combustion sources, and off-highway combustion sources. The default ratios assume that a specified portion (expressed as a percentage) of PM_{10} emissions are $PM_{2.5}$ emissions. For mechanical/fugitive dust, the method assumes that 21% of PM_{10} emissions are $PM_{2.5}$. For combustion sources, 99% of PM_{10} emissions are $PM_{2.5}$, and for off-highway combustion sources 89% of PM_{10} emissions are $PM_{2.5}$ (SCAQMD 2006). $PM_{2.5}$ emissions for fugitive dust and off-highway combustion sources were estimated using the default ratios.

Fugitive dust emissions from the actual drilling of the exploratory boring were estimated using a total suspended particulate (TSP) emission factor of 1.3 pounds per hole, which was obtained from EPA AP-42 Table 11.9-4, Uncontrolled Particulate Emission Factors for Open Dust Sources at Western Surface Coal Mines, dated July 1998. The resulting maximum potential emission estimates on a per site basis for fugitive dust as a result of surface disturbances are summarized in Table 4.2-3.

Table 4.2-3. Particulate Matter Emissions Associated with Surface Disturbances

Activity (per site or mile)	Disturbed Area (acres)*	PM_{10} Emission Factor (tons/acre-month)†	PM_{10} Emissions, Total (tons/month)	Duration of Project (months)‡	PM_{10} Emissions, Total (tons)	$PM_{2.5}$ Emissions, Total (tons)§
Exploration	1.10	0.11	0.12	1.5	0.18	0.04
Mine Development	20.00	0.11	2.20	2.0	4.40	0.92
Road Construction (per mile)	1.70	0.11	0.19	0.3	0.05	<0.01
Power Line Construction (per mile)	0.17	0.11	0.02	0.3	<0.01	<0.01
Mine Closure and Reclamation	20.00	0.11	2.20	1.0	2.20	0.46

* The average area of soil disturbance was obtained from Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios.

† The CARB document states that the emission factor is for site preparation work, which may include scraping, grading, loading, digging, compacting, light-duty vehicle travel, and other operations. Available at: <http://www.arb.ca.gov/ei/areasrc/ONEHTM/ONE7-7.HTM>.

‡ It has been estimated that 30 days would be required for each exploratory drilling, 40 days would be required to develop the mine site, 5 days per mile of new access road constructed, 5 days per mile of new power line constructed, and 20 days for mine closure and reclamation. At 20 days/month, the project duration for exploration, mine development, and mine closure and reclamation would be 1.5 months, 2.0 months, and 1.0 months, respectively.

§ Based on SCAQMD-derived default values for mechanical dust generating sources, e.g., construction, the $PM_{2.5}$ fraction of PM_{10} is 21%.

Vehicles/Equipment Tailpipe Emissions

During exploration, development, and mining operations, both on- and off-highway vehicles/equipment would generate gaseous exhaust emissions. Use of ultra-low-sulfur diesel fuel for vehicles and generators was also applied in the inventory. Table 4.2-4 summarizes the on-road equipment and vehicle roster for each of the various mine stages.

Table 4.2-4. Vehicle/Equipment Roster for "Typical or Hypothetical" Mine

Primary Equipment Description	hp	Fuel Type	Primary Equipment Quantity	Estimated Activity Schedule (days)	Estimated Equipment Usage Time (hr/day)
Exploratory Activity (per site)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	4	30	8.00
Water Truck	350	Diesel	1	30	8.00
Drill Rig (Travel)	350	Diesel	1	2	8.00
Drill Rig (Drilling)	400	Diesel	1	30	8.00
Mine Development (per mine site)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	10	60	8.00
Back Hoe, w/Bucket	85	Diesel	1	60	8.00
Crane, Hydraulic, Rough Terrain, 25−35 Ton	125	Diesel	1	60	8.00
Loader, Front End, w/Bucket	165	Diesel	1	60	8.00
Road Grader	350	Diesel	1	60	8.00
Truck, Dump, 10 Ton	235	Diesel	1	60	8.00
Truck, Flatbed, 2 Ton	210	Diesel	2	60	8.00
Water Truck	350	Diesel	1	60	8.00
Generator	1,100	Diesel	1	60	8.00
Truck, Semi, Tractor	310	Diesel	2	60	8.00
Mine Development (per mile of new access road)				(1 Crew)	(1 Crew)
Backhoe/Front Loader	350	Diesel	1	5	8.00
Road Grader	350	Diesel	1	5	8.00
Scraper	600	Diesel	1	5	8.00
Dozer	600	Diesel	1	5	8.00
Truck, Pick-Up	180	Gas	5	5	8.00
Truck, Semi, Tractor	310	Diesel	2	5	8.00
Water Truck	350	Diesel	1	5	8.00
Mine Development (per mile of new power line)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	5	5	8.00
Back Hoe, w/Bucket	85	Diesel	1	5	8.00
Digger, Distribution Type, Truck Mount	190	Diesel	1	5	8.00
Crane, Hydraulic, Rough Terrain, 25−35 Ton	125	Diesel	2	5	8.00
Backhoe/Front Loader	350	Diesel	1	5	8.00
Forklift, 5 Ton	200	Diesel	1	5	8.00
Truck, Flatbed, w/Bucket, 5 Ton	235	Diesel	2	5	8.00
Truck, Dump, 10 Ton	235	Diesel	1	5	8.00
Truck, Wire Puller, 3-Drum	310	Diesel	1	5	8.00
Roller/Compactor	200	Diesel	1	5	8.00
Water Truck	350	Diesel	1	5	8.00
Truck, Semi, Tractor	310	Diesel	2	5	8.00
Mine Operation (per site)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	5	730	8.00
Backhoe/Front Loader	350	Diesel	2	730	8.00
Water Truck	350	Diesel	1	730	8.00
Ore Haul Trucks	400	Diesel	12	927	N/A

Table 4.2-4. Vehicle/Equipment Roster for "Typical or Hypothetical" Mine (Continued)

Primary Equipment Description	hp	Fuel Type	Primary Equipment Quantity	Estimated Activity Schedule (days)	Estimated Equipment Usage Time (hr/day)
Mine Closure and Reclamation (per site)				(1 Crew)	(1 Crew)
Road Grader	350	Diesel	1	20	8.00
Truck, Pick-Up	180	Gas	5	20	8.00
Water Truck	350	Diesel	1	20	8.00
Truck, Semi, Tractor	310	Diesel	2	20	8.00

Note: Equipment roster assumed by Ninyo and Moore based on previous experience with similar types of projects.

On-road motor vehicle emissions for employee vehicles and haul trucks were calculated using EFs for on-road gasoline and diesel vehicles obtained from UDEQ, Division of Air Quality 2005 mobile source (Mobile 6) emission factors for Kane County. These data are the most recent available and are representative of the project area. However, the Mobile 6 SO_2 emission factors were adjusted to account for a more restrictive gasoline and diesel sulfur standard than was assumed in the State's analysis. In 2005, the sulfur content of the fuels did not take into account current federal regulations. In April 2006, EPA published new rule Non-road and Highway Fuel Regulations. Therefore, an adjustment to the Mobile 6 SO_2 emission factors was made as follows: the sulfur content of gasoline in the Mobile 6 runs was 160 ppm versus a current standard of 30 ppm, and the sulfur content of diesel in the Mobile 6 runs was 191.5 ppm versus a standard of 15 ppm. CO_2 emissions were also calculated as part of this analysis. Emission factors in lb/mile for on-road gasoline combustion were based on a CO_2 EF of 19.4 lb/gallon and assuming an average fuel economy of 25.5 miles per gallon (mpg). The 25.5 mpg fuel economy assumes a 50/50 mix of passenger vehicles with an average fuel economy of 27.5 mpg and light duty trucks with an average fuel economy of 23.5 mpg based on the proposed Corporate Average Fuel Economy (CAFÉ) Rule for 2010. Emission factors in lb/mile for on-road diesel combustion were based on a CO_2 EF of 22.2 lb/gallon and assuming an average fuel economy of 6.6 mpg. Off-highway CO_2 EF was calculated using CO_2 (g/hp–hr) = (BSFC × 453.6 – HC) × 0.87 × (44/12), where brake specific fuel consumption (BSFC) is 0.367 (g/hp–hr), hp is horsepower, hr is hour, HC is hydrocarbon EF, and 44 molecular weight (MW) of CO_2 and 12 is the MW carbon. Off-highway motor vehicle emissions for construction and mining equipment were calculated using EFs from *Exhaust and Crankcase Emission Factors for Non-Road Engines Modeling Compressive Ignition* (EPA 2004).

Daily and annual exploratory emissions were quantified using the anticipated timeline, type of equipment, quantity of equipment, hours of operation, and reasonable assumptions. Assumptions were made for missing data, including distance traveled by on-road vehicles (i.e., drill rig and support vehicle commute distance). Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel; Page, Arizona, for exploration projects located in the East Parcel; and Flagstaff, Arizona, for exploration projects located in the South Parcel. Drill rig and the support vehicles (i.e., gasoline pick-up trucks) were assumed to travel a round-trip distance of 73 miles for exploration activities located in the North Parcel, 121 miles for exploration activities located in the East Parcel, and 145 miles for exploration activities located in the South Parcel. Ore haul trucks were assumed to travel an average round-trip distance of 595 miles from the North Parcel, 507 miles from the East Parcel, and 523 miles from the South Parcel to the ore processing facility in Blanding, Utah. All of the ore haul truck travel routes selected were the shortest distances that avoid truck travel through Grand Canyon National Park.

OHVs and equipment were assumed to operate on average 8 hours per workday. The resulting maximum potential emission estimates for criteria and GHG pollutants are summarized in Table 4.2-5.

Table 4.2-5. Hypothetical/Typical Mine Vehicle/Equipment Exhaust Emissions in Tons per Mine Life

Proposed Withdrawal Area	NO_X	SO_2	CO	PM_{10}*	$PM_{2.5}$†	VOCs	CO_2‡
North Parcel							
Exploration	0.70	< 0.01	0.48	0.02	< 0.01	0.05	61.15
Mine Site	6.10	0.01	3.57	0.35	0.32	0.53	561.36
Access Roads	0.52	< 0.01	0.27	0.03	0.03	0.04	46.44
Power Lines	0.39	< 0.01	0.39	0.05	0.04	0.06	34.22
Mine Operations	130.62	0.12	84.09	8.03	7.48	12.24	13,039.93
Reclamation	0.44	< 0.01	0.43	0.02	0.02	0.04	41.04
Total	**138.78**	**0.13**	**89.23**	**8.50**	**7.89**	**12.96**	**13,784.14**
East Parcel							
Exploration	0.74	< 0.01	0.70	0.02	< 0.01	0.06	64.42
Mine Site	6.44	0.01	4.74	0.36	0.33	0.62	593.88
Access Roads	0.53	< 0.01	0.32	0.03	0.03	0.05	47.80
Power Lines	0.42	< 0.01	0.44	0.05	0.05	0.07	37.19
Mine Operations	121.45	0.11	86.17	7.72	7.17	12.11	12,066.45
Reclamation	0.50	< 0.01	0.62	0.02	0.02	0.05	46.46
Total	**130.08**	**0.12**	**93.01**	**8.21**	**7.60**	**12.97**	**12,856.20**
South Parcel							
Exploration	0.76	< 0.01	0.81	0.02	< 0.01	0.07	66.01
Mine Site	6.60	0.01	5.31	0.37	0.33	0.67	609.57
Access Roads	0.54	< 0.01	0.34	0.03	0.03	0.05	48.45
Power Lines	0.44	< 0.01	0.47	0.05	0.05	0.07	38.62
Mine Operations	120.05	0.11	88.53	7.67	7.13	12.24	11,912.29
Reclamation	0.53	< 0.01	0.72	0.02	0.02	0.06	49.08
Total	**128.91**	**0.12**	**96.18**	**8.17**	**7.55**	**13.15**	**12,724.02**

Notes: Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel; Page, Arizona, for exploration projects located in the East Parcel; and Flagstaff, Arizona, for exploration projects located in the South Parcel. Ore haul trucks were assumed to travel to uranium ore processing plant located in Blanding, Utah. Distances were estimated using Google Earth.

Emission factors for on-road gasoline and diesel vehicles obtained from UDEQ Kane County Mobile 6.2 and for off-highway diesel vehicles/equipment from EPA (2004).

* For on-road equipment, PM emission factor was used to calculate PM_{10} emissions.

† The SCAQMD-derived default ratio for estimating $PM_{2.5}$ is that for off-highway combustion sources, 89% of PM_{10} is $PM_{2.5}$, and for on-road combustion sources, 99% of PM_{10} is $PM_{2.5}$.

‡ EFs in lb/mile for on-road gasoline combustion were based on a CO_2 EF of 19.4 lb/gallon and assuming an average fuel economy of 25.5 mpg. EFs in lb/mile for on-road diesel combustion were based on a CO_2 EF of 22.2 lb/gallon and assuming an average fuel economy of 6.6 mpg. Off-highway CO_2 EF was calculated using CO_2 (g/hp–hr) = (BSFC × 453.6 – HC) × 0.87 × (44/12) where BSFC is 0.367 (g/hp–hr), HC is hydrocarbon EF, and 44 MW of CO_2 and 12 is the MW of CO.

Vehicles/Equipment Travel over Paved and Unpaved Surfaces

During the exploration activities, fugitive dust emissions would be generated from vehicles and equipment traveling over the paved and unpaved surfaces. Emissions from vehicle/equipment travel on paved roads were calculated based on EFs developed from Equation 2 in AP-42, Chapter 13.2.1, Paved Roads (EPA 2006a). Emissions from vehicle/equipment travel on unpaved roads were calculated based on EFs developed from Equation 2 in AP-42, Chapter 13.2.2, Unpaved Roads (EPA 2006b). Daily and annual exploratory emissions were quantified using the anticipated timeline, type of equipment, quantity of equipment, hours of operation, and reasonable assumptions. Assumptions were made for missing data, including where the vehicles and equipment were mobilizing from and the distance traveled by on-road vehicles.

Each proposed withdrawal parcel was broken into four quadrants. The linear distance to the nearest paved highway from the center point of each quadrant was determined using Google Earth. An additional factor of 50% was added to the dirt road values to account for the sinuosity of the roads.

Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel; Page, Arizona, for exploration projects located in the East Parcel; and Flagstaff, Arizona, for exploration projects located in the South Parcel. However, depending on the withdrawal parcel, the following was assumed for the average miles per day traveled by the drill rig and other vehicles:

- North Parcel – 27 miles per day on paved and 46 miles per day on unpaved surfaces
- East Parcel – 106 miles per day on paved and 15 miles per day on unpaved surfaces
- South Parcel – 135 miles per day on paved and 10 miles per day on unpaved surfaces

Ore haul trucks were assumed to travel the following average miles per day on paved and unpaved surfaces:

- North Parcel – 549 miles per day on paved and 46 miles per day on unpaved surfaces
- East Parcel – 492 miles per day on paved and 15 miles per day on unpaved surfaces
- South Parcel – 513 miles per day on paved and 10 miles per day on unpaved surfaces

The resulting maximum potential emission estimates for fugitive dust from on-road vehicle/equipment travel of paved and unpaved surfaces are summarized in Table 4.2-6.

Table 4.2-6. Hypothetical/Typical Mine Vehicle/Equipment Fugitive Dust Emissions Over 20 Years

Proposed Withdrawal Area	PM_{10} (lb/day)	Total PM_{10} (in tons)	$PM_{2.5}$ (lb/day)	Total $PM_{2.5}$ (in tons)
North Parcel				
Exploration	247.26	2.44	24.78	0.24
Mine Site	622.33	18.67	62.35	1.87
Access Roads	362.36	0.91	36.35	0.09
Power Lines	572.77	1.43	57.50	0.14
Mine Operations	1,639.08	626.84	181.36	70.35
Reclamation	362.36	3.62	36.35	0.36
Total	**3,806**	**654**	**399**	**73**
East Parcel				
Exploration	90.51	0.85	9.34	0.09
Mine Site	227.82	6.83	23.50	0.70
Access Roads	134.65	0.34	14.02	0.04
Power Lines	214.33	0.54	22.43	0.06
Mine Operations	765.83	313.63	92.25	38.62
Reclamation	134.65	1.35	14.02	0.14
Total	**1,568**	**323**	**176**	**40**

Table 4.2-6. Hypothetical/Typical Mine Vehicle/Equipment Fugitive Dust Emissions Over 20 Years (Continued)

Proposed Withdrawal Area	PM_{10} (lb/day)	Total PM_{10} (in tons)	$PM_{2.5}$ (lb/day)	Total $PM_{2.5}$ (in tons)
South Parcel				
Exploration	63.58	0.58	6.73	0.06
Mine Site	160.03	4.80	16.93	0.51
Access Roads	95.84	0.24	10.30	0.03
Power Lines	153.47	0.38	16.62	0.04
Mine Operations	631.43	257.74	79.49	32.97
Reclamation	95.84	0.96	10.30	0.10
Total	**1,200**	**265**	**140**	**34**

Notes: Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel; Page, Arizona, for exploration projects located in the East Parcel; and Flagstaff, Arizona, for exploration projects located in the South Parcel. Ore haul trucks were assumed to travel to uranium ore processing plant located in Blanding, Utah. Distances were estimated using Google Earth.

EF was calculated using Equation 1 and 2 in Chapter 13.2.1 Paved Roads of EPA (2006a). (Note: There may be situations where low silt loading and/or low average weight would yield calculated negative emissions from Equation 1. If this occurs, the emissions calculated from Equation 1 should be set to zero.)

Mine Operation Emissions

Emissions from construction activities and uranium mining activities were considered as project emissions. Primary sources within each of these activities are related to fuel (gasoline and diesel) use in internal combustion engines and to fugitive dust emitted into the ambient air from various sources. The methodology used to calculate these emission sources is described in detail below, and emission summary tables are provided. For uranium mining activity emissions, a “typical” 300-tpd mine production rate was assumed, as described in Chapter 2.

The only currently active mine within the proposed withdrawal area is the Arizona 1 Mine, located approximately 35 miles south of Fredonia, Arizona, within the North Parcel. Estimated emissions of criteria and HAPs from continued uranium mining activities were extracted from the Class II Permit Application for the proposed 500-tpd Arizona 1 Mine Project prepared for Denison and submitted to the ADEQ in January 2008. Therefore, mine emissions associated with a “typical” 300-tpd mine were assumed to be 60% (300/500) of the Arizona 1 Mine projected emissions. Ninyo and Moore calculated construction and vehicle emissions not covered by the air permit application. The resulting maximum potential emission estimates for mine operations are summarized in Table 4.2-7.

Table 4.2-7. Typical Mine Projected Facility-Wide Annual Emissions (tons/year)

Emissions	Standby Generator (Cummins 700 hp)	Material Handling Sources	Storage Pile Fugitive Sources	Road Fugitive Sources	Storage Tank Emissions	Total (tons/year)
CO	0.21	–	–	–	–	0.21
NO_X	1	–	–	–	–	1
PM_{10}	0.071	0.414	0.096	3.738	–	4.319
VOC	0.08	–	–	–	0.297	0.377
SO_2	0.07	–	–	–	–	0.07
Lead	–	3.01E-14	1.37E-13	5.44E-12	–	5.609E-12
Radon*	–	–	–	–	–	$\leq$ 10 mrem/yr
CO_2	48.3	–	–	–	–	48.3

Source: Denison (2008:Table 3-1).

Notes: Typical mine emissions assumed to be 60% (300/500) of the Arizona 1 Mine Emissions. 3.01E-14 tons/year is equal to 0.0000000000000301 tons/year.

* Radon emission limitation for those subject sources as defined in 40 CFR Part 61 Subpart B.

Climate and Greenhouse Gas Emissions

There is currently no standard methodology or model to determine how an individual source or project's (i.e., multiple sources) GHG emissions may translate into physical impacts to the local or global environment. The project's GHG emissions would increase the concentration of the GHG in the atmosphere in combination with GHG emissions from other sources. However, the project's cumulative GHG emissions would be insignificant, compared with the amount of GHG emissions generated worldwide.

GREENHOUSE GAS EMISSIONS ASSOCIATED WITH ALTERNATIVES

GHG emissions would occur as result of the mining activities described in the Air Quality Introduction above (e.g., exploration activities, mine development, mining operations, and mine closure and reclamation). When considering GHG emissions from the combustion of gasoline or #2 fuel oil (diesel), more than 99.99% of those emissions are in the form of CO_2; therefore, for this analysis, only CO_2 emissions are considered. However, not all GHGs have uniform global warming potentials (GWPs). Nitrous oxide (N_2O) has a GWP of 200 times the potential of CO_2. If the remaining 0.1% of emissions were nitrous oxide, it would only account for approximately 2% of the GWP, a figure that is insignificant in relation to other uncertainties in this analysis.

CO_2 emissions associated with those mobile and stationary combustion sources are provided in the summary of maximum total emission table for each alternative, below.

4.2.4 Impacts Common to All Alternatives

Under all alternatives, pollutants would be emitted into the atmosphere during mine operations. The amount of pollutants emitted would depend on the level of mineral exploration, development, operation, and reclamation under each alternative. Under Alternative A (No Action) emission would be the greatest when compared to that of the alternatives.

The main pollutant to be released from the construction and operation of the mines would be particulate matter, emitted as fugitive dust. Particulate matter emissions can be expected from land clearing, earth-moving, mine development, access road and power line construction, and mine closure and reclamation activities. Operational fugitive dust would result from ore and waste rock removal, transport, storage activities, and wind erosion of exposed surfaces.

Ore haulage near Grand Canyon National Park may result in particulates' being transported into the borders of the Park. Under worst-case meteorological conditions, a small reduction in visibility could occur if an observer were looking through the potential fugitive dust plume when haul road traffic was present. However, any visibility reduction should be temporary, as traffic would pass along the haul road in less than a minute.

Exploration Impacts on Air Quality

Air quality impacts from exploration activities would result primarily from vehicle/equipment and fugitive dust emissions. The operation of drill rigs and other mobile sources would result in the combustion of diesel and gasoline fuels, which would have intermittent and short-term emissions of CO, SO_2, NO_X, PM_{10}, $PM_{2.5}$, VOCs, and CO_2. The diesel and gasoline engines would be built in accordance with EPA mobile source regulations [40 CFR 85] and would only be operated on an as-needed basis, further minimizing vehicle exhaust emissions.

The potential impacts resulting from exploration activities would occur over a limited geographic area, as each exploration site is relatively small in area (1.1 acres), and would be intermittent and temporary in duration. Under normal atmospheric conditions, fugitive dust tends to settle out within a few kilometers. Emissions from exploration-related activities would be reduced with the implementation of routine, commonly accepted operating procedures to curb dust (e.g., limiting vehicle speeds, maintaining stabilized soil surfaces, active watering during drilling activities). However, exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers. To assess the current value of the air quality resource condition indicators, measurement of existing background air pollutant concentrations, topography, and meteorological data in the specific area of any potential mine sites would be needed.

Mine Development Impacts on Air Quality

Air quality impacts from the development phases of the project (e.g., construction of access roads and power lines) would result primarily from vehicle/equipment and fugitive dust emissions. The operation of construction equipment and other mobile sources would result in the combustion of diesel and gasoline fuels, which in turn would result in emissions of CO, SO_2, NO_X, PM_{10}, $PM_{2.5}$, VOCs, and CO_2. The diesel and gasoline engines would be built in accordance with EPA mobile source regulations [40 CFR 85] and would only be operated on an as-needed basis, further minimizing vehicle exhaust emissions.

Operation of vehicles/equipment has the potential to generate nuisance fugitive dust during mine development activities. The generation of fugitive dust emissions during mine development activities would be reduced using appropriate compliance measures identified in the Compliance with Environmental Regulations and Permitting section.

The potential impacts resulting from development activities would occur over a limited geographic area, as each mine site is relatively small in area (20 acres). Under normal atmospheric conditions, fugitive dust tends to settle out within a few kilometers. However, exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers.

Mine Operation Impacts on Air Quality

Air quality impacts from mining operations would result primarily in fugitive dust emissions generated during the hauling of the uranium ore to the processing facility located in Blanding, Utah. Additionally, fugitive dust (e.g., material handling, storage piles, and road fugitive emission) and vehicle/equipment exhaust emissions would be generated during the mining of the uranium ore. Emissions from the mining activities would mainly consist of CO, SO_2, NO_X, PM_{10}, $PM_{2.5}$, VOCs, and CO_2. CO_2, a GHG, would also be produced from the fuel combustion sources used to carry out mining operations. GHGs include CO_2, methane (CH_4), and N_2O; however, CO_2 is the main GHG of concern when dealing with fuel combustion sources.

However, not all GHGs have uniform GWPs. Nitrous oxide has a GWP of 200 times the potential of carbon dioxide. If the remaining 0.1% of emissions were nitrous oxide, it would only account for approximately 2% of the GWP, a figure that is insignificant in relation to other uncertainties in this analysis.

None of the proposed mines would have potential emissions in quantities large enough to trigger a PSD review, as defined in Section 3.2.2. Therefore, each mine would be considered a minor source relative to the PSD permitting process and would only require a State of Arizona Class II Non-Title V air quality permit. Compliance with the permit and the applicable state regulations would minimize the air quality impacts of mine operation.

For information purposes only, these emissions are considered less than significant with respect to those regulations governing PSD/NSR. Those regulations define significance to be emissions of criteria pollutants to be greater than 250 tons per year. However, this analysis is not meant or intended to be an increment consumption analysis.

Mining operations related to all of the alternatives would be expected to result in increases in ambient air pollutant concentrations. Use of the unpaved and paved roads by the ore haul trucks would result in potential increases in fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur and would be minimized by speed limit restrictions on unpaved roads. However, exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers. The extent of the impact is dependent on the proximity of the mining activity to the Grand Canyon National Park boundary. Areas of the Park that are closer to mining operations could be impacted greater than areas that are farther away.

Air quality impacts would be mitigated through use of a compliance plan following the control measures as discussed in the Arizona 1 Mine Compliance Plan provided below. This reference was provided for informational purposes only. It should be noted that each individual mine would be required to submit a compliance plan specific to its operations. These plans will provide specific compliance measures for the individual project.

Mine Closure and Reclamation Impacts on Air Quality

Air quality impacts from the mine closure and reclamation would result primarily from vehicle/equipment and fugitive dust emissions. The operation of heavy-equipment and other mobile sources would result in the combustion of diesel and gasoline fuels, which would have localized increases in emissions of CO, SO_2, NO_X, PM_{10}/$PM_{2.5}$, VOCs, and CO_2. The diesel and gasoline engines would be built in accordance with EPA mobile source regulations [40 CFR 85] and would only be operated on an as-needed basis, further minimizing vehicle exhaust emissions.

The potential impacts resulting from mine closure and reclamation activities would occur over a limited geographic area, as each mine site is relatively small in area (20 acres), and would be intermittent and temporary in duration. Under normal atmospheric conditions, fugitive dust tends to settle out within a few kilometers and with the incorporation of sufficient dust control measures, emissions from mine closure and reclamation activities would not significantly affect local or regional air quality, although exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers. Reclamation activities would include revegetation of the mine site, which would result in a reduction of bare ground, stabilizing the previously disturbed soil surfaces and decreasing the potential for generation of wind-blown fugitive dust. Moreover, because the mines would be reclaimed following closure it would be expected that a decrease in fugitive emissions would occur as a result of the stabilization of soils and the re-establishment of vegetation.

The operation of the vehicles/equipment has the potential to generate fugitive dust during mine closure and reclamation activities. The generation of fugitive dust emissions during mine closure and reclamation activities would be reduced using appropriate compliance measures.

Compliance with Environmental Regulations and Permitting

Compliance measures for exploration activities, mine development, mine operations, and mine closure/reclamation would be required and applied in a manner consistent with federal, state, and local air quality regulations. These compliance measures would be based on the individual activity and for the air pollutant to be controlled.

A compliance plan for the Arizona 1 Mine was created by Denison and submitted to ADEQ within the *Class II Permit Application for the Proposed Arizona 1 Mine Project* (Denison 2008). This compliance plan identifies applicable requirements of AAC Article 6 of R18-2 pertaining to roadways/streets, emission requirements for material handling and storage piles, opacity requirements for point and non-point sources, and standards of performance for storage vessels for petroleum liquids. This plan identifies specific control measure options to be used as needed to control project-related fugitive dust emissions.

The magnitude of the particulate matter emissions expressed herein was calculated based on the diligent use of the control measures, as follows:

- Keep dust and other particulate emissions to a minimum by reducing travel speeds on unpaved surfaces.
- Apply gravel to silty pockets and/or use magnesium chloride or a similar soil stabilizer on dust problem areas along the haul road.
- Install a track-out device (i.e., grizzly, gravel pad, and/or wash down pad) adjacent to the entrance of an area accessible to the public to control carryout and track-out.
- On the last day of active operations prior to a weekend or holiday, apply water or chemical stabilizer to maintain a stabilized surface.
- Water excavated soil piles hourly or cover them with temporary coverings.
- Moisten excavated soil prior to loading haul trucks.
- Cover all loads of dirt leaving the site. Apply water to ground surfaces prior and during earth-moving activity.
- Apply chemical stabilizers, per manufacturer's directions, and/or water as necessary prior to expected high wind events. During periods of high winds, work activities would cease temporarily.

For the purpose of this analysis, these measures will be assumed to be applicable to any other mines approved within the withdrawal area and all the alternatives described in this EIS.

Hazardous Air Pollutant Impact Assessment

HAPs can cause various adverse health effects. They are not regulated under the NAAQS. However, emission standards for HAPs have been established in regulations contained at 40 CFR 61 and 63. These regulations were established to ensure that HAP emissions do not exceed concentrations determined to be detrimental to human health and the environment.

Uranium mining operations have the potential to emit ionizing radiation. The negative health effects attributed to ionizing radiation depend on many parameters, including the dose (i.e., amount of radiation received), the dose rate (i.e., rate at which radiation is delivered), and the type of ionizing radiation (i.e., alpha, beta, x-ray, or gamma). The types of radiation emitted from typical underground uranium mines will include alpha and beta particles and x-rays and gamma rays. These types of radiation are emitted from the radioactive materials found in and around the uranium ore body.

The natural environment consists of cosmic radiation and many other radioactive elements (e.g., hydrogen-3, carbon-14, potassium-40, radium-226, rubidium-87, uranium 235 [^{235}U], uranium 238 [^{238}U], and thorium-232). Both ^{238}U and Thorium-232 are ubiquitous in soil, with average concentrations on the order of a few parts per million. ^{238}U is considered a parent element of a radioactive decay series, which means the "parents" decay to "daughters" that are also radioactive. Naturally occurring uranium is typically about 99.3% ^{238}U (DUF_6 Guide 2010).

Radioactive materials are present in air, water, and soil. Concentrations of radioactive materials are expressed in units of radioactivity per volume or mass. Typical concentrations of naturally occurring uranium and radium-226 in normal soil are on the order of one pico-Curie per gram (pCi/g) (ADEQ 2008). One pCi is equivalent to 2.22 atoms of the radionuclide decaying each minute.

When ionizing radiation deposits energy in living matter, it produces a physical and biological effect, which is quantified in terms of dose. The dose is expressed in radiological units, known as roentgen equivalent man, or rem. However, because a rem is so large it is often divided by 1,000 and called an mrem.

A progeny of ^{238}U is radon-222, which is a colorless, odorless, and inert gas. Radon-222 diffuses into the atmosphere from rocks, soil, and building materials. When radon-222 decays, it releases alpha particles, which have been linked to negative human health effects. A discussion of the exposure pathways for radon is provided in Chapter 3, Section 3.2.3, of this EIS.

The following text is excerpted from ADEQ's (2008) Technical Review and Evaluation of Application for Air Quality Permit No. 46700 for Denison's Arizona 1 Mine:

> Radon gas emanates from the earthen materials containing uranium such as natural soil and the ore stockpiles. Once airborne, the gas will be transported by prevailing winds and will decay to its progeny. Uranium and its progeny will be present in dust from the mining operations.
>
> The natural background radon gas concentration in the vicinity of the Arizona 1 Mine is on the order of 0.2 picocuries per liter (pCi/l) or 125 mrem/yr. Based upon previous evaluations of the project (McKleveen 1988) the highest potential exposure projected from radon would be on the order of 106 mrem/year. The mineshaft vent emissions are subject to limitations set forth of 40 Code of Federal Regulations (CFR) part 61 subpart B at 10 mrem/year. Radiation exposure from dust associated with the mining operation is dependent on the concentrations of dust in the air and the activity of the compounds in the dust. Since these values are variable, it is not feasible to estimate the radiation impact from the dust.
>
> Direct radiation from haul trucks will be about 2 mrem/hr at the truck bed, about 0.3 mrem/hr on the shoulder of the roadbed, and normal background at about 96 feet from the trailer. As a truck passes, individuals standing on the shoulder of the road would receive a dose of radiation too small to quantify. These radiation concentrations can be put in perspective by comparing them to what naturally occurs in various locations. For example, naturally occurring radiation levels for a person living in the Colorado Plateau will receive 400-500 mrem/year based on EPA estimates. Thus, the estimated radiation exposure at the Arizona 1 Mine site [or from hauling ore] does not present a significant risk to human health.

The haul trucks are designed such that the material being transported is covered; therefore, emissions from the ore being hauled are controlled/mitigated and not allowed to escape the vehicle as a fugitive source. It is the regulatory agency's responsibility to protect human health and the environment. The site-specific mine plan will include mitigation and control measures for the transportation of uranium ores from the mine site to the processing facility.

The uranium ore haul trucks are in accordance with permit conditions and regulations (49 CFR Part 171, 172, and 177). According to the Washington State Department of Health, Office of Radiation Protection, General Radiation Fact Sheet titled "What is Ionizing Radiation?"[11] uranium ore contains alpha emitters. These alpha particles consist of two neutrons and two protons ejected from the nucleus of an atom. The alpha particle is identical to the nucleus of a helium atom. Examples of alpha emitters are radium, radon,

[11] Available at: <http://www.doh.wa.gov/ehp/rp/factsheets/fsdefault.htm>.

thorium, and uranium. Because alpha particles are charged and relatively heavy, they interact intensely with atoms in materials they encounter, giving up their energy over a very short range. In air, their travel distances are limited to approximately an inch. Alpha particles are easily shielded against and can be stopped by a single sheet of paper. Since alpha particles cannot penetrate the dead layer of the skin, they do not present a hazard from exposure external to the body. Given this lower radioactivity of the uranium ore, the enclosed metal containers in which the ore is transported provides adequate shielding from the ionizing radiation.

In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation. The impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. This could include analysis of other hazardous air pollutants including, but limited to, heavy metals (e.g., arsenic, cadmium, chromium, lead and mercury) and other potential inhalation hazards such as airborne silica. The analysis could provide an evaluation of potential exposure pathways and impacts to the public, workers, ground and surface water, soils, vegetation, and native and domestic animals over the short and long term for the site-specific mine.

VISCREEN Modeling Results

Plume visibility impacts were analyzed at the Grand Canyon using EPA's VISCREEN model (Version 1.01) following the guidance in *Workbook for Plume Visual Impact Screening and Analysis* (Revised), October 1992, EPA-454/R-92-02 (EPA 1992). VISCREEN uses two successive levels of screening (Levels 1 and 2). Level 1 screening is the most simplified approach and is designed to provide a very conservative estimate of a plume's visual impact using worst-case meteorological conditions.
The Level 1 analysis is designed to simulate the most conservative (highest) plume visual impact that an observer may possibly experience. These worst-case meteorological conditions includes extremely stable atmospheric conditions, a wind speed of 1 meter per second persisting for 12 hours, and assumes the wind would transport the plume directly adjacent to the hypothetical observer. Furthermore, the Level-1 analysis assumes the plume is uniformly distributed vertically and normally (Gaussian) distributed horizontally over a 22.5-degree sector in the direction of transport towards the Class I area. The following technical options for the VISCREEN modeling analysis were selected:

- Hypothetical 1 gram per second emission rate;
- Default particle characteristics assumed;
- Default (zero) emission rates for primary NO_2, soot, and sulfate;
- Default background visual range for the region (275 km);
- Default Level 1 parameters (background O_3 equal to 0.06 ppm, wind speed equal to 1 meter per second, stability index of 6, and a plume source observer angle of 11.25 degrees).

The Level 1 screening analysis was performed for a plume generated by a "typical" 300-tpd mine operation at the North, East, and South parcels. The operation of the "typical" mine would cause elevated emissions from numerous process points and ground-level emissions of fugitive dust. For the Level l screening, all the elevated and ground-based emissions were lumped together as if they originated from a single source. The maximum particulate matter emission rate input value was determined to be the total tons per year of PM_{10} from the standby generator, material handling operations, storage piles, and road fugitive sources, plus the tailpipe emissions generated from the on-site vehicles/equipment.

The maximum NO_x emission rate input value was determined to be the total tons per year of NO_X from the standby generator and tailpipe emissions generated from the on-site vehicles/equipment. The maximum NO_X and PM_{10} emission rate input values are summarized in Table 4.2-8.

VISCREEN also requires source-observer distances and maximum/minimum receptor distances, which have been summarized in Table 4.2-9.

Table 4.2-8. VISCREEN Maximum Tons per Year NO_X and PM_{10} Emission Rate Input Values

Area	PM_{10} (tpy)	NO_X (tpy)
North Parcel	6.7	15.8
East Parcel	6.7	16.2
South Parcel	6.7	16.4

Table 4.2-9. VISCREEN Source-Receptor Distances

Area	Source-Observer Distance (km)	Minimum Source-Observer Distance (km)	Maximum Source-Observer Distance (km)
North Parcel*	10.9	10.9	39.4
East Parcel†	6.6	6.6	10.3
South Parcel‡	12.4	12.4	54.1

* The Arizona 1 Mine location was used as the representative emission source within the North Parcel.
† A hypothetical mine located in the center of the East Parcel was used as the location of the representative emission source within the East Parcel.
‡ The Canyon Mine was used as the representative emission source within the South Parcel.

VISCREEN uses two screening criteria to ascertain whether a plume has the potential to be perceptible to untrained observers under "reasonable worst-case" conditions. The first screening criterion is a delta E (ΔE) of 2.0. ΔE is used to characterize the perceptibility of given plume based on the color difference between the plume and the viewing background (e.g., sky, cloud, or terrain feature). The second screening criterion is a contrast value of 0.05 (EPA 1992). VISCREEN calculates a ΔE and contrast both from inside and outside the study area. The resulting maximum visual impacts inside Grand Canyon National Park are summarized in Table 4.2-10.

Note that only results "inside" the receptor area (i.e., Grand Canyon National Park) were considered in this analysis, as the area "outside" the receptor area is not considered a Class I area. These results are based on emission data from the Arizona 1 Mine and one particular location within each of the proposed withdrawal parcels.

Potential impacts on regional haze or visibility were evaluated. VISCREEN modeling efforts concluded the "typical" mining project would comply with the criteria established by the EPA for maximum visual impacts inside Grand Canyon National Park.

The modeling results provided in Table 4.2-10 show that plume impacts from a typical mining operation are below the absolute contrast value but exceed the ΔE. Therefore, a Level 2 analysis would be required to determine potential impacts to Grand Canyon National Park. A valid analysis of potential air quality impacts associated with any of the alternatives cannot be made without descriptions of each of the individual proposed exploration and mine sites, including precise location (topography), atmospheric conditions, roster of equipment, number of mine shafts, and ore production rates, etc. Without knowledge of the specific location of each air pollutant source, these variables cannot be considered.

In each study area, the maximum impacts occur outside the area looking in, in other words, views outside Grand Canyon National Park. Note that only results "inside" the receptor area were considered in this analysis, as the area "outside" the receptor area is generally not protected.

Table 4.2-10. Class I Visibility Modeling Results—Maximum Visual Impacts Inside Grand Canyon National Park

Background	Theta (degrees)	Azimuth (degrees)	Distance (km)	Alpha (degrees)	ΔE Screening Criteria	ΔE Plume	Absolute Contrast Screening Criteria	Absolute Contrast Plume
North Parcel								
Sky	10	165	39.4	4	2.00	1.691	0.05	0.034
Sky	140	165	39.4	4	2.00	0.340	0.05	−0.009
Terrain	10	165	39.4	4	2.00	3.681	0.05	0.032
Terrain	140	165	39.4	4	2.00	0.315	0.05	0.004
East Parcel								
Sky	10	150	10.3	19	2.00	0.843	0.05	0.019
Sky	140	150	10.3	19	2.00	0.340	0.05	−0.006
Terrain	10	84	6.6	84	2.00	3.893	0.05	0.010
Terrain	140	84	6.6	84	2.00	0.093	0.05	0.000
South Parcel								
Sky	10	165	54.1	3	2.00	1.32	0.05	0.021
Sky	140	165	54.1	3	2.00	0.184	0.05	−0.006
Terrain	10	84	12.4	84	2.00	2.178	0.05	0.008
Terrain	140	84	12.4	84	2.00	0.053	0.05	0.000

Notes:

Alpha = The horizontal angle between a line of sight and the plume centerline.

Azimuth = The horizontal angle between the line connecting the emission source and the observer and the line of sight.

Distance = The distance between the emission source and the most distant Class I area boundary.

Theta = Scattering angle, which is the angle between direct solar radiation and the line of sight.

Arizona 1 Mine Modeling Results Summary

Arizona 1 Mine facility-wide annual emission limits were obtained from the Arizona 1 Mine Air Permit Application (Denison 2008). Criteria pollutant emissions from the operation of the Arizona 1 Mine are relatively low, as shown in Table 4.2-11.

Table 4.2-11. Arizona 1 Mine Projected Facility-Wide Annual Emissions

	CO (tpy)	CO (lb/hr)	NO_X (tpy)	NO_X (lb/hr)	PM_{10} (tpy)	PM_{10} (lb/hr)	VOC (tpy)	VOC (lb/hr)	SO_2 (tpy)	SO_2 (lb/hr)	Pb (tpy)	Pb (lb/hr)
Standby Generator (Cummins 700 hp)	0.21	3.58	1.0	16.63	0.071	1.18	0.08	1.35	0.07	1.10	–	–
Material Handling Sources	–	–	–	–	0.69	0.16	–	–	–	–	5.02E-14	4.58E-08
Storage Pile Fugitive Sources	–	–	–	–	0.16	0.04	–	–	–	–	2.28E-13	2.08E-07
Road Fugitive Sources	–	–	–	–	6.23	1.07	–	–	–	–	9.07E-12	6.20E-06
Storage Tank Emissions	–	–	–	–	–	–	0.297	0.07	–	–	–	–
Total	**0.2**	**3.58**	**1.0**	**16.63**	**7.2**	**2.44**	**0.38**	**1.42**	**0.07**	**1.10**	**9.35E-12**	**6.46E-06**

Source: Denison (2008:Tables 3-1 and 3-2).

Note: 5.02-14 tpy is equal to 0.0000000000000502 tpy.

Maximum SO_2, NO_2, and CO concentrations for the operation of the standby generator were analyzed using the EPA SCREEN3 model (version 96043). SCREEN3 is a very conservative Gaussian plume modeling analysis that predicts maximum ground-level concentrations using worst-case meteorological conditions from point, area, and volume emission sources. A Gaussian plume model assumes that a pollutant plume is carried downwind from its emission source and that concentrations in the plume can be approximated by assuming that the highest concentrations occur on the horizontal and vertical midlines of the plume, with the distribution about these midlines characterized by bell-shaped (i.e., Gaussian) concentration profiles.

Maximum PM_{10} concentrations from Arizona 1 Mine emissions (e.g., standby generator, material handling, and fugitive dust) were analyzed using the American Meteorological Society and EPA Regulatory Model Improvement Committee Dispersion Model (AERMOD version 07026). AERMOD is the EPA preferred model for near-field applications to access impacts to NAAQS and both Class I and Class II increments. Recently issued (or in the process of being reviewed) air quality permits by the ADEQ for the Denison mines (Arizona 1, Pinenut, Canyon, and EZ mine) have all performed air quality impact analyses using AERMOD to calculate impacts to the NAAQS and Class I increments inside and on the boundary of Grand Canyon National Park. Tables 4.2-12 through 4.2-14 were obtained from the ADEQ (2008) *Technical Review and Evaluation of Application for Air Quality Permit No. 46700* for Denison's Arizona 1 Mine.

Table 4.2-12. Arizona 1 Mine Modeling Results

Pollutant	Averaging Period	Year	Highest Modeled Concentration* (µg/m^3)	Background Concentration (µg/m^3)	Total Concentration (µg/m^3)	NAAQS (µg/m^3)	% Ambient Standard
SO_2	3-Hour	N/A	17.3	73	90.3	1,300	6.9%
	24-Hour	N/A	7.7	16	23.7	365	6.5%
	Annual	N/A	1.5	3	4.5	80	5.6%
NO_2	Annual	N/A	23.2	4	27.2	100	27.2%
CO	1-Hour	N/A	62.6	582	644.6	40,000	1.6%
	8-Hour	N/A	43.8	582	625.8	10,000	6.3%
PM_{10}	24-Hour	2002	43.1	47	90.1	150	60.1%
	Annual	2001	9.64	18	27.6	Revoked	-

Sources: ADEQ (2008:Table 4); Denison (2008).

Note: N/A = Not applicable.

* Highest: first-high modeled concentrations are presented for both short-term and annual averaging periods, per ADEQ request.

Regional haze modeling was conducted using CALPUFF for Grand Canyon National Park. CALPUFF is an advanced integrated atmospheric pollution dispersion model. Table 4.2-13 presents the regional haze modeling results from the Arizona 1 Mine and haul road traffic, compared with the 5% change in light extinction (ΔB_{ext}) screening level. A change in ΔB_{ext} that is less than 5% is considered acceptable by the EPA.

Modeling results indicate that predicted visibility impairment is below the 5% screening criteria for all days in the 3-year meteorological period (2001–2003), except for one day in the year 2002. This one isolated event in the 3-year data set occurred on March 19, 2002, approximately 7.5 miles from the Arizona 1 Mine Site at the northern edge of Grand Canyon National Park. The specific cause of the isolated event on March 19, 2002, is unknown.

Table 4.2-13. Grand Canyon Visibility Impact Modeling Results

Visibility Parameter	Averaging Period	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2001	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2002	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2003	Screening Threshold
Max ΔB_{ext} (%)	24-Hour	3.29	5.76	3.56	5%
# days > 5%	N/A	0	1	0	N/A
# days > 10%	N/A	0	0	0	N/A

Source: ADEQ (2008:Table 5).
Note: Visibility Impacts (% degradation).
= Number.
N/A = not applicable.

Table 4.2-14 presents the regional haze modeling results, showing that at the ninety-eighth percentile, the regional haze impacts are below the threshold 5% ΔB_{ext}. The proposed draft FLAG approach uses a modified algorithm and monthly relative humidity values and takes the ninety-eighth percentile to screen out seven days of haze-type visibility impairment per year.

Table 4.2-14. Grand Canyon Visibility Impact Modeling Results New FLAG Approach

Visibility Parameter	Averaging Period	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2001	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2002	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2003	Screening Threshold
Max ΔB_{ext} (%)	24-Hour	2.56	4.87	4.00	5%
# days > 5%	N/A	0	0	0	N/A
# days > 10%	N/A	0	0	0	N/A

Source: ADEQ (2008:Table 6).
Note:Visibility impacts ninety-eighth percentile values (% degradation).
= Number.
N/A = not applicable.

These model results indicate that operation of the Arizona 1 Mine will not adversely impact visibility within Grand Canyon National Park. Since the proposed withdrawal parcels border Grand Canyon National Park, it is possible that emissions from proposed mine operation activities could impact the Park. However, this is relative to the location of the actual proposed mine within the parcel and must be determined for each source location. Current governing laws and regulations would require any future exploration and development activities to demonstrate that the proposed activity would not impact Class I areas such as Grand Canyon National Park, and a Level 2 analysis would be required to determine potential impacts on the Park.

Table 4.2-15 compares the maximum total emissions in tons from exploration, mine site development, mine operations, and mine reclamation for each of the proposed alternatives. Alternative A (No Action) would result in the highest emissions. The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces.

Table 4.2-15. Total Emission in Tons (20-year time frame)

Alternative	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
A	4,659.74	10.53	3,147.23	18,520.80	2,673.42	460.75	451,601.76
B	1,545.43	3.70	992.23	7,104.75	1,007.72	154.70	151,781.91
C	2,636.20	6.17	1,768.28	10,684.75	1,556.65	265.02	257,104.18
D	3,912.49	9.00	2,606.28	16,270.53	2,335.89	388.62	380,732.25

4.2.5 Impacts of Alternative A: No Action (No Withdrawal)

Assumptions for Impact Analysis

Under Alternative A, reasonably foreseeable uranium mining exploration activities could occur at 728 exploration sites, leading to the potential development of 30 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines, which are existing mines) and 22.4 miles of new access roads and power lines over the next 20 years. Additionally, a total of 945 acres within the North Parcel, 107 acres within the East Parcel, and 312 acres within the South Parcel would be disturbed. The number of areas disturbed includes both areas of new disturbance and areas already disturbed at the existing mines. Table 4.2-16 summarizes the activities associated with Alternative A, including the number of sites and the total acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Table 4.2-16. Summary of Activity Associated with Alternative A over 20 Years

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	21	2	7
Anticipated Number of Exploration Projects	504	56	168
Miles of New Road (miles)	16.4	2.4	3.6
Number of Haul Trips	221,298	22,240	73,967
Miles of New Power Lines (miles)	16.4	2.4	3.6
Acreage of New Mine Footprint (20 acres/mine)	360	40	120
Acreage of New Roads (1.7 acres/mile)	28	4	6
Acreage of New Power Lines (0.17 acre/mile)	3	1	1
Acreage of Exploration (1.1 acres/site)	554	62	185
Total Disturbed Acreage (acres)	945	107	312

Summary of Impacts

Table 4.2-17 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative A. Under Alternative A, over a 20-year period approximately 3,916 tons NO_X, 10 tons SO_2, 2,577 tons CO, 16,222 tons PM_{10}, 2.395 tons $PM_{2.5}$, 401 tons VOCs, and 385,705 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-17. Summary of the Maximum Total Emission Associated with Alternative A (in Tons)

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	132	28	–	–
Bore Hole Drilling Emissions	–	–	–	2	2	–	–
Vehicle and Equipment Tailpipe Emissions	521	< 1	418	14	< 1	39	45,515
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	1,372	137	–	–
Subtotal	*521*	*< 1*	*418*	*1,520*	*167*	*39*	*45,515*
Mine Development (mine site)							
Surface Disturbance Emissions from Development (Mine Site)	–	–	–	132	28	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Mine Site)	187	< 1	122	11	10	17	17,243
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Mine Site)	–	–	–	439	44	–	–
Subtotal	*187*	*< 1*	*122*	*582*	*82*	*17*	*17,243*
Mine Development (access roads)							
Surface Disturbance Emissions from Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Road Construction)	12	< 1	6	< 1	< 1	1	1,051
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Road Construction)	–	–	–	16	2	–	–
Subtotal	*12*	*< 1*	*6*	*17*	*2*	*1*	*1,051*
Mine Development (power lines)							
Surface Disturbance Emissions from Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Power Line Construction)	9	< 1	9	1	1	1	789
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	26	3	–	–
Subtotal	*9*	*< 1*	*9*	*27*	*4*	*1*	*789*
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	90	6	19	389	389	34	4,347
Vehicle and Equipment Tailpipe Emissions from Development	3,826	3	2,558	238	221	367	381,358
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	15,595	1,785	–	–
Subtotal	*3,916*	*10*	*2,577*	*16,222*	*2,395*	*401*	*385,705*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	66	14	–	–
Vehicle and Equipment Tailpipe Emissions from Reclamation	14	< 1	15	1	< 1	1	1,298
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	85	9	–	–
Subtotal	*14*	*< 1*	*15*	*152*	*23*	*1*	*1,298*
Total over 20 years for all activity*	**4,660**	**10**	**3,147**	**18,521**	**2,673**	**461**	**451,602**

* There are no existing federal or state regulations that provide significance criteria for a 20-year period.

Under Alternative A, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they do occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely that these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative A, over a 20-year period, approximately 4,660 tons NO_X, 10 tons SO_2, 3,147 tons CO, 18,521 tons PM_{10}, 2,673 tons $PM_{2.5}$, 461 tons VOCs, and 451,602 tons CO_2 would be emitted to the atmosphere during the mine operation activities. Emissions would be the greatest under this alternative.

Impacts at the individual mine sites would be nearly identical for all alternatives.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-17. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, the project's GHG emissions would increase the concentration of the GHG in the atmosphere by a very small amount in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts.

4.2.6 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

The Alternative B withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations.

Assumptions for Impact Analysis

Under Alternative B, reasonably foreseeable exploration activities would occur at 11 exploration sites, possibly leading to the development of 11 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines), with 6.4 miles of new access roads and power lines. A total of 163 acres within the North Parcel, 0 acre within the East Parcel, and 1 acre within the South Parcel would be disturbed. The number of areas disturbed includes both new areas and areas already disturbed at the existing mines. Table 4.2-18 summarizes the activities associated with Alternative B, including the number of sites and the total acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Table 4.2-18. Summary of Activity Associated with Alternative B

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	10	0	1
Anticipated Number of Exploration Projects	10	0	1
Miles of New Road (miles)	6.4	0	0
Number of Haul Trips	98,978	0	7,247
Miles of New Power Line (miles)	6.4	0	0
Acreage of New Mine Footprint (20 acres/mine)	140	0	0
Acreage of New Roads (1.7 acres/mile)	11	0	0
Acreage of New Power Lines (0.17 acre/mile)	1	0	0
Acreage of Exploration (1.1 acres/site)	11	0	1
Total Disturbed Acreage (acres)	323	0	32

Summary of Impacts

Table 4.2-19 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative B. Under Alternative B, over a 20-year period approximately 1,459 tons NO_X, 4 tons SO_2, 936 tons CO, 6,757 tons PM_{10}, 961 tons $PM_{2.5}$, 147 tons VOCs, and 143,905 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-19. Summary of the Maximum Total Emission Associated with Alternative B (in Tons)

Exploration / Activity	NO_x	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	2	< 1	–	–
Bore Hole Drilling Emissions	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions	8	< 1	6	< 1	< 1	< 1	677
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	25	2	–	–
Subtotal	*8*	*< 1*	*6*	*27*	*3*	*< 1*	*677*
Mine Development (Mine Site)							
Surface Disturbance Emissions From Development (Mine Site)	–	–	–	48	10	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Mine Site)	68	< 1	41	4	3	6	6,223
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Mine Site)	–	–	–	191	19	–	–
Subtotal	*68*	*< 1*	*41*	*244*	*33*	*6*	*6,223*
Mine Development (Access Roads)							
Surface Disturbance Emissions From Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Road Construction)	3	< 1	2	< 1	< 1	< 1	297
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Road Construction)	–	–	–	6	1	–	–
Subtotal	*3*	*< 1*	*2*	*6*	*1*	*< 1*	*297*

Table 4.2-19. Summary of the Maximum Total Emission Associated with Alternative B (in Tons), Continued

Exploration / Activity	NO_x	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Mine Development (Power Lines)							
Surface Disturbance Emissions From Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Power Line Construction)	2	< 1	2	< 1	< 1	< 1	219
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	9	1	–	–
Subtotal	*2*	*< 1*	*2*	*9*	*1*	*< 1*	*219*
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	33	2	7	142	142	12	1,594
Vehicle and Equipment Tailpipe Emissions From Development	1,426	1	929	88	82	135	142,312
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	6,526	736	–	–
Subtotal	*1,459*	*4*	*936*	*6,757*	*961*	*147*	*143,905*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	24	5	–	–
Vehicle and Equipment Tailpipe Emissions From Reclamation	5	< 1	5	< 1	< 1	< 1	459
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	37	4	–	–
Subtotal	*5*	*< 1*	*5*	*62*	*9*	*< 1*	*459*
Total	**1,545**	**4**	**992**	**7,105**	**1,008**	**155**	**151,782**

Direct Impacts

Under Alternative B, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely that these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative B, over a 20-year period, approximately 1,545 tons NO_X, 4 tons SO_2, 992 tons CO, 7,105 tons PM_{10}, 1,008 tons $PM_{2.5}$, 155 tons VOCs, and 151,782 tons CO_2 would be emitted to the atmosphere. This represents an approximately 60% decrease in air pollutant emissions when compared to that of the No Action Alternative (No Withdrawal). Emissions would be least under this alternative, compared with the other alternatives.

Impacts at the individual mine sites would be nearly identical for all alternatives.

Arizona 1 Mine facility-wide annual emission limits were obtained from the Arizona 1 Mine Air Permit Application (Denison 2008). Maximum SO_2, NO_2, and CO concentrations for the operation of the stand-by generator were analyzed using the EPA SCREEN3 model (version 96043). Maximum PM_{10} concentrations from Arizona 1 Mine emissions (e.g., standby generator, material handling, and fugitive dust) were analyzed using the American Meteorological Society and EPA Regulatory Model Improvement Committee Dispersion Model (AERMOD version 07026).

These model results indicate the operation of the Arizona 1 Mine will not adversely impact visibility within Grand Canyon National Park. Since the proposed withdrawal parcels border Grand Canyon National Park, it is possible that emissions from future mining operations in those locations could possibly impact the Park. However, this is relative to the location of the actual proposed mine within the parcel and must be determined for each source location. Therefore, the use of Arizona 1 Mine as a surrogate represents only that operation. Other mining activities under Alternative B would require individual analyses. Data for future mining activities under Alternative B are inconclusive.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-19. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, each project's GHG emissions would increase the concentration of the GHG in the atmosphere in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts. A reduction in GHG emissions of greater than 60% would be realized when comparing the GHG emissions from this alternative to that of the No Action Alternative (No Withdrawal).

4.2.7 Impacts of Alternative C: Partial Withdrawal (~650,000 acres)

The potential withdrawal under Alternative C is similar to that described for Alternative B, except it would apply to a smaller area—648,805 acres of federal lands, compared with approximately 1 million acres under Alternative B.

The Alternative C withdrawal would occur for a period of 20 years (same as the Alternative B withdrawal). No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations. After the expiration of the segregation period or signing of the ROD for this EIS, the proposed withdrawal under Alternative C would restrict the location of new mining claims and the exploration, development, and underground uranium mining activities similar to that for Alternative B but would apply to a smaller area.

Assumptions for Impact Analysis

Under Alternative C reasonably foreseeable uranium mining exploration activities would occur at 207 exploration sites, leading to the development of 14 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines), and 12.1 miles of new access roads and power lines. Additionally, a total of 320 acres within the North Parcel, 54 acres within the East Parcel, and 158 acres within the South Parcel would be disturbed. The number of areas disturbed includes both new areas and areas already disturbed at the existing mines. Table 4.2-20 summarizes the activities associated with Alternative C, including the number of sites and the total acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Table 4.2-20. Summary of Activity Associated with Alternative C

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	13	1	4
Anticipated Number of Exploration Projects	94	28	85
Miles of New Road (miles)	9.1	1.2	1.8
Number of Haul Trips	132,338	11,120	40,607
Miles of New Power Line (miles)	9.1	1.2	1.8
Acreage of New Mine Footprint (20 acres/mine)	200	20	60
Acreage of New Roads (1.7 acres/mile)	15	2	3
Acreage of New Power Lines (0.17 acre/mile)	2	1	1
Acreage of Exploration (1.1 acres/site)	103	31	94
Total Disturbed Acreage (acres)	320	54	158

Summary of Impacts

Table 4.2-21 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative C. Under Alternative C, over a 20-year period approximately 2,354 tons NO_X, 6 tons SO_2, 1,545 tons CO, 9,869 tons PM_{10}, 1,451 tons $PM_{2.5}$, 240 tons VOCs, and 231,843 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-21. Summary of the Maximum Total Emission Associated with Alternative C

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	38	8	–	–
Bore Hole Drilling Emissions	–	–	–	1	1	–	–
Vehicle and Equipment Tailpipe Emissions	151	< 1	134	4	< 1	12	13,162
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	302	30	–	–
Subtotal	*151*	*< 1*	*134*	*344*	*39*	*12*	*13,162*
Mine Development							
Surface Disturbance Emissions From Development (Mine Site)	–	–	–	79	17	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Mine Site)	112	< 1	72	6	6	10	10,330
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Mine Site)	–	–	–	269	27	–	–
Subtotal	*112*	*< 1*	*72*	*354*	*49*	*10*	*10,330*

Table 4.2-21. Summary of the Maximum Total Emission Associated with Alternative C (Continued)

Exploration / Activity	NOX	SO2	CO	PM10	PM2.5	VOCs	CO2
Mine Development (Access Roads)							
Surface Disturbance Emissions From Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Road Construction)	6	< 1	3	< 1	< 1	1	567
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Road Construction)	–	–	–	9	1	–	–
Subtotal	*6*	*< 1*	*3*	*9*	*1*	*1*	*567*
Mine Development (Power Lines)							
Surface Disturbance Emissions From Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Power Line Construction)	5	< 1	5	1	1	1	425
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	14	1	–	–
Subtotal	*5*	*< 1*	*5*	*15*	*2*	*1*	*425*
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	54	4	11	233	233	20	2,608
Vehicle and Equipment Tailpipe Emissions From Development	2,300	2	1,533	143	133	220	229,235
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	9,494	1,085	–	–
Subtotal	*2,354*	*6*	*1,545*	*9,869*	*1,451*	*240*	*231,843*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	40	8	–	–
Vehicle and Equipment Tailpipe Emissions From Reclamation	8	< 1	9	< 1	< 1	1	776
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	52	5	–	–
Subtotal	*8*	*< 1*	*9*	*92*	*14*	*1*	*776*
Total	**2,636**	**6**	**1,768**	**10,685**	**1,557**	**265**	**257,104**

Direct Impacts

Under Alternative C, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative C, over a 20-year period, approximately 2,636 tons NO_X, 6 tons SO_2, 1,768 tons CO, 10,685 tons PM_{10}, 1,557 tons $PM_{2.5}$, 265 tons VOCs, and 257,104 tons CO_2 would be emitted to the atmosphere. This represents an approximately 40% decrease in air pollutant emissions when compared to that of the No Action Alternative (No Withdrawal).

Impacts at the individual mine sites would be nearly identical for all alternatives.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-21. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, each project's GHG emissions would increase the concentration of the GHG in the atmosphere in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts. A reduction in GHG emissions of greater than 40% would be realized when comparing the GHG emissions from this alternative to that of the No Action Alternative (No Withdrawal).

4.2.8 Impacts of Alternative D: Partial Withdrawal (~300,000 acres)

The withdrawal proposed in Alternative D would apply to approximately 292,088 acres of federal lands. As with Alternatives B and C, the Alternative D withdrawal would occur for a period of 20 years and no new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid rights were first established. Mineral exploration and development on mining claims with valid existing rights would continue under the respective BLM or Forest Service surface management regulations.

After the expiration of the segregation period or signing of the ROD for this EIS, the potential withdrawal under Alternative D would continue to restrict the location of new mining claims and exploration, development, and underground uranium mining activities similar to that for Alternative B but would apply to a smaller area (292,088 acres of federal land).

Assumptions for Impact Analysis

Under Alternative D reasonably foreseeable uranium mining exploration activities would occur at 431 exploration sites, leading to the potential development of 26 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines) and 19.1 miles of new access roads and power lines. Additionally, a total of 688 acres within the North Parcel, 54 acres within the East Parcel, and 209 acres within the South Parcel would be disturbed. The number of areas disturbed includes both new areas and areas already disturbed at the existing mines. Table 4.2-22 summarizes the activities associated with Alternative D, including the number of sites and the total acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Table 4.2-22. Summary of Activity Associated with Alternative D

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	20	1	5
Anticipated Number of Exploration Projects	290	28	113
Miles of New Road (miles)	15.5	1.2	2.4
Number of Haul Trips	210,178	11,120	51,727
Miles of New Power Line (miles)	15.5	1.2	2.4
Acreage of New Mine Footprint (20 acres/mine)	340	20	80
Acreage of New Roads (1.7 acres/mile)	26	2	4
Acreage of New Power Lines (0.17 acre/mile)	3	1	1
Acreage of Exploration (1.1 acres/site)	319	31	124
Total Disturbed Acreage (acres)	688	54	209

Summary of Impacts

Table 4.2-23 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative D. Under Alternative D, over a 20-year period approximately 3,412 tons NO_X, 8 tons SO_2, 2,227 tons CO, 14,683 tons PM_{10}, 2,140 tons $PM_{2.5}$, 347 tons VOCs, and 336,194 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-23. Summary of the Maximum Total Emission Associated with Alternative D

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	78	16	–	–
Bore Hole Drilling Emissions	–	–	–	1	1	–	–
Vehicle and Equipment Tailpipe Emissions	309	< 1	251	8	< 1	23	26,995
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	795	80	–	–
Subtotal	*309*	*< 1*	*251*	*883*	*97*	*23*	*26,995*
Mine Development							
Surface Disturbance Emissions from Development (Mine Site)	–	–	–	114	24	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Mine Site)	161	< 1	103	9	8	15	14,869
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Mine Site)	–	–	–	404	41	–	–
Subtotal	*161*	*< 1*	*103*	*528*	*73*	*15*	*14,869*
Mine Development (Access Roads)							
Surface Disturbance Emissions from Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Road Construction)	10	< 1	5	1	1	1	893
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Road Construction)	–	–	–	15	1	–	–
Subtotal	*10*	*< 1*	*5*	*16*	*2*	*1*	*893*

Table 4.2-23. Summary of the Maximum Total Emission Associated with Alternative D (Continued)

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Mine Development (Power Lines)							
Surface Disturbance Emissions from Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Power Line Construction)	8	< 1	8	1	1	1	668
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	24	2	–	–
Subtotal	*8*	*< 1*	*8*	*25*	*3*	*1*	*668*
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	78	5	16	337	337	29	3,767
Vehicle and Equipment Tailpipe Emissions from Development	3,334	3	2,211	207	192	318	332,427
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	14,139	1,610	–	–
Subtotal	*3,412*	*8*	*2,227*	*14,683*	*2,140*	*347*	*336,194*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	57	12	–	–
Vehicle and Equipment Tailpipe Emissions from Reclamation	12	< 1	13	1	1	1	1,113
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	79	8	–	–
Subtotal	*12*	*< 1*	*13*	*136*	*20*	*1*	*1,113*
Total	**3,912**	**9**	**2,606**	**16,270**	**2,336**	**389**	**380,732**

Direct Impacts

Under Alternative D, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely that these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative D, over a 20-year period, approximately 3,912 tons NO_X, 9 tons SO_2, 2,606 tons CO, 16,270 tons PM_{10}, 2,336 tons $PM_{2.5}$, 389 tons VOCs, and 380,732 tons CO_2 would be emitted to the atmosphere. This represents an approximately 10% decrease in air pollutant emissions when compared to that of the No Action Alternative (No Withdrawal).

Impacts at the individual mine sites would be nearly identical for all alternatives.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-23. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, each project's GHG emissions would increase the concentration of the GHG in the atmosphere by a very small amount in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts. A reduction in GHG emissions of greater than 10% would be realized when comparing the GHG emissions from this alternative to that of the No Action Alternative (No Withdrawal).

Cumulative Impacts

Past and present actions within the proposed withdrawal area besides uranium mining that contribute to air quality impacts include motorized and non-motorized travel, recreational use, and livestock grazing. The reasonably foreseeable future activities are expected to continue as current with respect to these activities. The cumulative impacts of these past and present actions are represented by the existing air quality in the project area, as described in detail in Section 3.2. The sum total of these impacts constitutes the baseline or ambient air quality in the region. It is this baseline by which a comparison of future activities will be measured, including uranium mining.

On a local scale, cumulative increases in air pollution emissions could occur where reasonably foreseeable new exploration and mining operations are located in the study area. Each additional mine (including exploration, mine development, mine operations, and mine closure/reclamation) can be expected to contribute approximately 256 to 644 total tons PM_{10} over its 7-year duration. Cumulative impacts would be limited, as particulates settle quickly near the mine sites and haul roads. Each of the new underground mines would be required to obtain an ADEQ-issued air permit. These air permits would require certain air quality protection measures, which would ensure that cumulative air emissions remain at or below the ambient air quality standards. Based on the permit issued to Arizona 1 mine (i.e., a Class II minor source), it is reasonable to assume future mines would be permitted in the same class and would be considered minor sources.

As was discussed in Chapter 3, with respect to air quality impacts, any future uranium mine would need to demonstrate through site-specific analysis the contribution of that source to the airshed. This analysis would include a modeling exercise to determine the cumulative impacts on the region's sensitive (i.e., Class I and II) areas. The majority of the development effects of the reasonably foreseeable future mining projects would be mitigated by the fact that these projects would be constructed over different periods. Both development- and operation-related air emissions are not expected to have a significant impact on air quality within the area, since the mines would likely have varying development schedules and must adhere to federal, state, and local regulations for the protection of ambient air quality.

Since portions of the proposed withdrawal area border Grand Canyon National Park, areas of the Park that are closer to mining operations would have the potential to be impacted more than areas that are farther away. The BLM and Forest Service may consider mitigation measures during site-specific NEPA analyses that could reduce impacts on federal lands, including the Grand Canyon National Park.

With respect to cumulative impacts for GHG, as GHG emissions are integrated across the regional or global atmosphere, it is not possible to determine the cumulative impact on global climate from emissions associated with any number of particular projects, nor is it expected that such disclosure would provide a practical or meaningful effects analysis for project decisions.

4.3 GEOLOGY AND MINERAL RESOURCES

4.3.1 Impact Assessment Methodology and Assumptions

There are seven resource condition indicators for analysis of mineral resources:

- Availability of high mineral potential lands;
- Number of ore deposits mined;
- Potential for subsidence and alteration of geology or topography;
- Amount of uranium mined as percentage of known domestic resources, domestic production, and domestic demand;
- Depletion of uranium resources within proposed withdrawal area;
- Amount of uranium mined as percentage of global production and demand; and
- Cumulative amount of high potential uranium resource lands withdrawn from exploration and development.

The availability of high mineral potential lands and the cumulative amount of high potential lands withdrawn from location and entry under the Mining Law are calculated solely from the acres of mineral estate withdrawn (mineral estate refers to the ownership of the minerals at or beneath the surface of the land, which may be separate from owning the surface of the lands). The number of ore deposits mined is taken directly from the RFD scenarios (see Appendix B).

Historically, there has been no subsidence associated with existing breccia pipe mines, and with the exception of removal of ore from the subsurface, after reclamation there would be no permanent alteration of the surface geology or topography. This resource condition indicator will not vary by alternative and is not further analyzed.

The amount of uranium mined consists of three components: uranium extracted from the four mines with approved plans of operation, uranium from discovered breccia pipes, and uranium extracted from yet-to-be-developed mines (see Table 3.3-1). The amount of uranium extracted from the four mines with approved plans of operation is based on published estimates of uranium reserves in these four pipes, minus reserves already mined (personal communication, Spiering 2010). The amount of uranium from mines that have not yet been developed is based either on available estimates of uranium reserves in specific pipes or on the assumption used in the RFD that the average mine produces 1,500 tons U_3O_8. The depletion of uranium resources within the withdrawal area is calculated based on an estimated uranium resource of 39,666 tons U_3O_8.

The domestic uranium reserve is estimated at 269,500 tons U3O8 (EIA 2011a). Domestic annual uranium production is estimated at 1,875 tons U3O8 (EIA 2010a). Current domestic annual uranium requirement for nuclear reactors is estimated at 23,040 tons U3O8 (World Nuclear Association 2011). Current global annual production of uranium is estimated at 57,000 tons U3O8 (TradeTech 2010). Total global annual uranium requirement is estimated at 84,000 tons U3O8 (TradeTech 2010). The impacts analysis relies on comparing the amount of uranium expected to be mined under each alternative to each of the above-mentioned parameters: domestic uranium reserves, annual domestic uranium production, annual domestic reactor requirement, annual global uranium production, and annual global reactor requirement. With the exception of domestic uranium reserves, these parameters reflect the annual rates of uranium production or use. In order to make the comparison to these parameters, the total amount of uranium expected to be mined in the proposed withdrawal area under each alternative is divided by 20, in order to obtain an annual rate of expected uranium production.

Spatial boundaries for the above resource condition indicators are not restricted solely to the proposed withdrawal area, as the resource condition indicators encompass both the U.S. and global markets. Temporally, analysis has been restricted to a 20-year time frame, identical to the approach used in the RFD. Impacts are considered long term if they exceed 5 years in duration.

Historically, mining interests targeting breccia pipe deposits in Arizona have developed mines on public lands, as opposed to state or private lands. The proposed withdrawal of federal lands from mineral location and entry would limit the overall number of breccia-pipe mines that could develop on federal lands; however, there would be additional industrial capacity for the development of mines beyond the proposed withdrawal area. The proposed withdrawal of federal lands from mineral location and entry has the potential to shift development onto private and state lands within the vicinity of the proposed withdrawal area unless reserved federal mineral estate is present; these lands are still considered to have high mineral potential for uranium (Finch et al. 1990). However, historically little exploration has taken place on these lands, and although uranium mining on state land has been pursued, no uranium mine has ever been approved or developed on state or private land in northern Arizona. The realistic potential for development of uranium mines on state and private lands is likely relatively limited. The amount of mine development that could result on state and private lands in the vicinity of the proposed withdrawal area has not been quantified.

Tables 4.3-1 and 4.3-2 provide definitions of impact magnitude and duration, respectively, as they relate to geology and mineral resources.

Table 4.3-1. Magnitude and Degrees of Effects on Geology and Mineral Resources

Attribute of Effect	Description Relative to Geology and Mineral Resources
Magnitude	
No Impact	Would not produce changes in the number of operating mines, amount of produced uranium, or the availability of high mineral potential lands.
Minor	Changes the number of operating mines or amount of produced uranium by less than 20%, or changes the availability of high mineral potential lands by less than 20%.
Moderate	Changes the number of operating mines or amount of produced uranium by 20% to 50%, or changes the availability of high mineral potential lands by 20% to 50%.
Major	Changes the number of operating mines or amount of produced uranium by more than 50%, or changes the availability of high mineral potential lands by more than 50%.

Table 4.3-2. Duration Definition of Effects on Geology and Mineral Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

4.3.2 Incomplete or Unavailable Information

There was no incomplete or unavailable information necessary to form the impacts analysis for geology and mineral resources.

4.3.3 Compliance with Environmental Regulations and Permitting

Reclamation takes place concurrent with mining activities and after completion of mining. Reclamation includes the restoration of the surface topography, vegetation, and drainage. Historically, reclamation of mines (Hack Canyon, Hermit, and Pigeon) has included removal of surface stockpiles, removal of all equipment and structures, sealing of the mine shaft, regrading of the site and access roads, and revegetation. In the future, reclamation may also include the restoration of the subsurface groundwater flow regime, prevention of surface or groundwater from entering the closed mine, and prevention of drainage from the mine to groundwater aquifers. Decisions about reclamation requirements are made on a case-by-case basis as part of the approval of the plan of operations.

4.3.4 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

Over the next 20 years, if no withdrawal occurs, the high mineral potential lands within the proposed withdrawal area would remain fully available for exploration and development of uranium deposits associated with breccia pipes. The number of ore bodies mined could increase from four to 30, yielding approximately 39,666 tons U_3O_8 over a 20-year time frame.

As described in the RFD scenario (see Appendix B), under Alternative A it is likely that the industrial capacity for mining uranium will exceed the amount of uranium resources estimated to be present and economically able to be mined in the proposed withdrawal area (39,666 tons U_3O_8). As described in Table 3.3-1, this estimate includes only 15% of the estimated 163,380 tons U_3O_8 of uranium endowment in the proposed withdrawal area. For the purposes of this impact assessment, mining occurring under Alternative A over the 20-year period would represent 100% depletion of the estimated uranium resource in the proposed withdrawal area that is currently economic to mine; however, it should be noted that a large portion of the estimated uranium endowment will remain unmined. Direct impacts associated with mineral resources are considered long term and permanent.

In the past, conventional mining techniques have not removed all uranium from the deposit; uranium of grades considered too low to be economically mined has been left in place; however, under modern mining techniques little uranium ore above background concentrations may be expected to be left in place. Previously removed and stockpiled rock would also be backfilled into the mine as waste rock (Denison 2010a). Indirect impacts also would include the subsurface disturbance and exposure of this low-grade remnant uranium ore and waste rock, which could result in mobilization of dissolved uranium into groundwater. No estimates have been made of the magnitude of low-grade uranium ore that might remain in a reclaimed mine. The effects of mine drainage are considered elsewhere in this document. The indirect impacts associated with mineral resources are considered long term.

Cumulative Impacts

Of the approximately 9,100 square miles of lands designated as high mineral potential for uranium in northern Arizona and southern Utah, almost 50% have previously been withdrawn from mineral location and entry, reducing the overall amount of high mineral potential lands available for uranium mining. There would be no further cumulative loss of these high mineral potential lands to mining availability under Alternative A.

The proposed withdrawal will only affect locatable minerals. The proposed withdrawal area has additional potential for leasable and salable minerals, and development of these mineral resources would continue. With respect to leasable minerals, the proposed withdrawal area has no or low potential for coal, phosphate, potash, or sodium deposits. Oil and gas potential within the East and South parcels is generally considered low, although little exploration has been conducted within the area. Portions of the North Parcel have been rated as having moderate potential for oil and gas based on oil shows in several wells. The proposed withdrawal area has also been rated as moderately favorable for the occurrence of low-temperature geothermal resources, although extensive geothermal exploration has not occurred (BLM 2007).

With respect to salable minerals in the proposed withdrawal area, sand and gravel deposits exist but are relatively isolated within the North and South parcels and are mostly associated with the Moenkopi Formation and alluvial deposits. In the East Parcel, gravel deposits of relatively large quantity and good quality have formed at the bottom of the western slope of the Kaibab monocline. Building materials (common variety, primarily flagstone and limestone) are widespread throughout the proposed withdrawal area, primarily associated with the Moenkopi and Kaibab Limestone Formations. Cinder deposits are limited to the far southwest corner of the North Parcel in the vicinity of Mount Trumbull (BLM 2007).

Development of leasable and salable minerals is expected to occur incrementally and in diverse locations. Geologically, the occurrence of leasable and salable minerals in the same locations as breccia pipe uranium deposits is unlikely. Cumulative impacts from leasable and salable minerals would be expected to be minor.

Direct, indirect, and cumulative impacts for Alternative A and all other alternatives are summarized in Table 4.3-3.

Table 4.3-3. Summary of Direct, Indirect, and Cumulative Impacts for All Alternatives

Resource Category Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 acres)	Alternative D Partial Withdrawal 20 Years (~300,000 acres)
Availability of High Mineral Potential Lands in the Proposed Withdrawal Area	All Available	None Available	30% Available	70% Available
Amount of Uranium Mined (tons U_3O_8)*	39,666	10,658	21,158	33,158
Number of Ore Deposits Mined	30	11	18	26
Potential for Subsidence or Alteration of Geology or Topography	None	None	None	None
Amount Mined as Percentage of Domestic Reserves	15	4	8	12
Amount Mined Annually as Percentage of Annual Domestic Production	107	28	56	88
Amount Mined Annually as Percentage of Annual Domestic Reactor Requirement	9	2	5	7
Amount Mined Annually as Percentage of Annual Global Production	3	1	2	3
Amount Mined Annually as Percentage of Annual Global Reactor Requirement	2	1	1	2
Percent Depletion of Uranium Resources within Withdrawal Area	100	27	53	84
Cumulative Percentage of High Uranium Potential Lands Withdrawn	50	70	60	55

* Amount of uranium mined based on the following criteria for each alternative:

Alternative A – Known reserves in existing mines and breccia pipes (10,658 tons U_3O_8), estimated resources in discovered breccia pipes (4,500 tons U_3O_8), and 15% of the estimated uranium endowment of 163,380 tons U_3O_8 (24,507 tons U_3O_8).

Alternative B – Known reserves in existing mines and breccia pipes (10,658 tons U_3O_8).

Alternative C – Known reserves in existing mines and breccia pipes (10,658 tons U_3O_8), and an additional estimated 7 mines (10,500 tons U_3O_8).

Alternative D – Known reserves in existing mines and breccia pipes (10,658 tons U_3O_8), and an additional estimated 15 mines (22,500 tons U_3O_8).

4.3.5 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

The Proposed Action would close all of the high mineral potential lands within the proposed withdrawal area to location and entry for 20 years. New exploration or development occurring on existing mining claims within the withdrawal area could only be allowed if valid existing rights to those claims were established. The number of ore bodies mined could increase from four to 11, yielding approximately 10,658 tons U_3O_8 over a 20-year time frame; this estimate is based on the estimated uranium reserves from known mineralized breccia pipes. Mining occurring under Alternative B over the next 20 years would deplete approximately 27% of the estimated uranium resource in the proposed withdrawal area. As compared to Alternative A, withdrawal under the Proposed Action would decrease the number of ore bodies mined from 30 to 11, and would decrease the amount of uranium mined from 39,666 tons U_3O_8 to 10,658 tons U_3O_8. Direct impacts associated with removal of mineral resources by mining are considered long term and permanent.

Indirect impacts would include the potential for exposure of remnant low-grade uranium ore in the subsurface from backfill or rock displacement. Indirect impacts associated with mineral resources are considered long term.

Cumulative Impacts

The Proposed Action would withdraw approximately 1,686 square miles; in conjunction with all previous withdrawals, the Proposed Action would result in cumulatively almost 70% of the lands with high mineral potential for uranium being unavailable for mineral location and entry. The withdrawal under the Proposed Action would increase the cumulative amount of lands withdrawn from 50% to 70%. Cumulative impacts associated with the withdrawal of mineral resources are considered long term; however, these cumulative impacts may not be permanent, as the withdrawal may not be renewed after the withdrawal period expires.

Cumulative impacts from the development of leasable and salable minerals would continue as described under Alternative A.

4.3.6 Impacts of Alternative C: Partial Withdrawal (~650,000 acres)

Direct and Indirect Impacts

Over the next 20 years, the partial withdrawal under Alternative C would close 648,805 acres of high mineral potential lands within the proposed withdrawal area to location and entry under the Mining Law, and no new exploration or development could occur on existing mining claims within the withdrawal area unless valid existing rights to those claims were established. The number of ore bodies mined could increase from four to 18, yielding approximately 21,158 tons U_3O_8 over a 20-year time frame. Mining occurring under Alternative C would deplete approximately 53% of the estimated uranium resource in the proposed withdrawal area. The withdrawal under the Alternative C would decrease the number of ore bodies mined from 30 to 18, and would decrease the amount of uranium mined from 39,666 tons U_3O_8 to 21,158 tons U_3O_8. Direct impacts associated with mineral resources are considered long term and permanent.

Indirect impacts would include the potential for exposure of remnant low-grade uranium ore in the subsurface from backfill or rock displacement. Indirect impacts associated with mineral resources are considered long term.

Cumulative Impacts

The partial withdrawal under Alternative C would withdraw approximately 1,087 square miles; in conjunction with all previous withdrawals, the partial withdrawal under Alternative C would result cumulatively in approximately 60% of the lands with high mineral potential for uranium being unavailable for mineral location and entry. The withdrawal under Alternative C would increase the cumulative amount of lands withdrawn from 50% to 60%. Cumulative impacts associated with the withdrawal of mineral resources are considered long term; however, these cumulative impacts may not be permanent, as the withdrawal may not be renewed after the withdrawal period expires.

Cumulative impacts from the development of leasable and salable minerals would continue as described under Alternative A.

4.3.7 Impacts of Alternative D: Partial Withdrawal (~300,000 acres)

Direct and Indirect Impacts

Over the next 20 years, the partial withdrawal under Alternative D would close 292,088 acres of high mineral potential lands within the proposed withdrawal area to location and entry under the Mining Law, and no new exploration or development could occur on existing mining claims within the withdrawal area unless valid existing rights to those claims were established. The number of ore bodies mined could increase from four to 26, yielding approximately 33,158 tons U_3O_8 over a 20-year time frame. Mining occurring under Alternative D would deplete approximately 84% of the estimated uranium resource in the proposed withdrawal area. The withdrawal under Alternative D would decrease the number of ore bodies mined from 30 to 26, and would decrease the amount of uranium mined from 39,666 tons U_3O_8 to 33,158 tons U_3O_8. Direct impacts associated with mineral resources are considered long term and permanent.

Indirect impacts would include the potential for exposure of remnant low-grade uranium ore in the subsurface from backfill or rock displacement. Indirect impacts associated with mineral resources are considered long term.

Cumulative Impacts

The partial withdrawal under Alternative D would withdraw approximately 478 square miles; in conjunction with all previous withdrawals, the partial withdrawal under Alternative D would result cumulatively in approximately 55% of the lands with high mineral potential for uranium being unavailable for mineral location and entry. The withdrawal under Alternative D would increase the cumulative amount of lands withdrawn from 50% to 55%. Cumulative impacts associated with the withdrawal of mineral resources are considered long term; however, these cumulative impacts may not be permanent, as the withdrawal may not be renewed after the withdrawal period expires.

Cumulative impacts from the development of leasable and salable minerals would continue as described under Alternative A.

4.4 WATER RESOURCES

4.4.1 Impact Assessment Methodology and Assumptions

Table 4.4-1 is a summary of the condition impact definitions used for the water resources assessment. Table 4.4-2 is a summary of the definitions for the expected duration of an impact, which are the same as those defined in Table 4.1-2. Duration of impact is analyzed separately from magnitude of impact. Resource condition indicators for water resources include the following:

- **Perched Aquifer Water Quantity.** Quantity of water discharge at springs and wells supported by perched groundwater zones that may be depleted by drainage into nearby subsurface openings related to mining.
- **Perched Aquifer Water Quality.** Chemical quality of water discharge at springs and wells supported by perched groundwater zones that may be affected by operations at nearby mine sites, with emphasis on metals.
- **R-aquifer[12] Water Quantity.** Quantity of water discharge at springs and deep wells supported by the R-aquifer system that may be depleted by mine water supply wells.
- **R-aquifer Water Quality.** Chemical quality of water discharge at springs and deep wells supported by the R-aquifer system that may be affected by operations at mine sites, with emphasis on metals.
- **Condition of Surface Waters.** Quantity and chemical quality (with emphasis on metals), and hydrologic function of perennial and ephemeral surface drainages that receive discharge from springs and/or surface water runoff. Quantity and quality of water retained in non-mine surface impoundments.

Potential changes in these resource condition indicators were evaluated quantitatively where sufficient data were available and qualitatively where data were insufficient for quantitative analysis.

The study area for the water resources analysis was selected to include local surface water drainage areas and groundwater basins that could potentially be impacted by reasonably foreseeable activities in the proposed withdrawal area. This impact assessment area includes the proposed withdrawal area and downstream/downgradient areas of the Grand Canyon watershed that are tributary to the Colorado River and the Little Colorado River, along with downstream/downgradient areas that are tributary to the Virgin River watershed. Additional areas remote from the proposed withdrawal area, such as the Virgin River in Utah and near Littlefield, Arizona, were also considered because of potential hydrologic connections.

The proposed withdrawal area is administered by either the BLM or the Forest Service. Areas downstream in the Grand Canyon watershed include lands administered by the NPS, State of Arizona, Havasupai Tribe, Hualapai Tribe, and Navajo Nation and include areas of private land. Within the water resources study area, a uniform set of water resource condition indicators were used for evaluation of resources and assessment of impacts (see Table 4.4-1).

[12] The R-aquifer is the regional carbonate aquifer composed of the Redwall Limestone, Temple Butte Formation, undifferentiated Cambrian dolomites, and Muav Limestone; this aquifer is also referred to as the Redwall-Muav aquifer or the regional aquifer. Perched aquifers are separated from the R-aquifer by low-permeability confining layers and are typically thin and discontinuous.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts

Condition Indicators	Impact Definitions	Impact Thresholds
No Impact		
Perched Aquifer Springs/ Wells		
Water Quantity/Quality	No change in the volume of spring discharge or water levels in non-mine wells would occur. No change in concentrations of uranium and arsenic in groundwater would occur.	No new and existing mines would be located within the groundwater drainage areas that support perched aquifer springs and wells.
R-aquifer Springs		
Water Quantity	No change in the volume of discharge would occur.	The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be 0% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells.
Water Quality	No change in concentrations of uranium and arsenic in groundwater would occur.	No mines would contribute impacted water to the R-aquifer.
R-aquifer Wells		
Water Quantity	No changes in water levels in non-mine R-aquifer wells would occur.	No decrease in water levels observed in non-mine R-aquifer wells would occur.
Water Quality	No change in concentrations of uranium and arsenic would occur in groundwater yielded to non-mine R-aquifer wells.	No mines would contribute impacted water to non-mine R-aquifer wells.
Surface Waters	No changes in stream flow, water quality, or sediment loads would occur.	No water quantity or water quality impacts to perched aquifer or R-aquifer springs that support surface water flow, and no surface disturbance would occur as a result of mining-related activities.
Negligible Impact		
Perched Aquifer Springs		
Water Quantity / Quality	Mines could be located within the groundwater drainage area of perched aquifers that support springs. Impact defined by the probability that a perched aquifer spring would have a mine located within its groundwater drainage area. Probability is estimated in accordance with methodology described in Section 4.4.1.	Between 0% and 5% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values indicates more than a 95% probability that any spring would not be impacted.
Perched Aquifer Wells		
Water Quantity / Quality	New or existing mines could be located within the groundwater drainage area of perched aquifers that support wells. Impact defined by the number of existing and new mines that might impact perched aquifer wells.	One to five mines might impact one well each. Rationale based on North Parcel, where 103 records for existing wells are reported. Five wells is less than 5% of the existing wells, many of which are likely inactive or abandoned, and 10 mines is about 25% of the new and existing mines anticipated for the North Parcel under Alternative A.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Negligible Impact, continued		
R-aquifer Springs		
Water Quantity	Changes in the volume of discharge would not be expected to be detectable, based on reported accuracies of measurement methods (Harmel et al. 2006).	The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and 5% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells.
Water Quality	Changes in the concentrations of uranium and arsenic in groundwater would not be expected to result in exceedance of estimated ambient concentrations.	At least one mine might contribute impacted water to the R-aquifer, but the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
R-aquifer Wells		
Water Quantity	Changes in water levels in non-mine R-aquifer wells might be detectable but would be expected to have a negligible effect on the operation of the wells impacted.	Decrease in water levels observed in non-mine R-aquifer wells would be expected to range between 0 and 10 feet after 5 years of pumping any single mine well, which is equivalent to the ADWR criterion for acceptable impact in Active Management Areas (AMAs).
Water Quality	Changes in the concentrations of uranium and arsenic in groundwater would not be expected to result in exceedance of estimated ambient concentrations.	At least one mine might contribute impacted water to the R-aquifer, and the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
Surface Waters		
Water Quantity	Changes in the volume of discharge from R-aquifer springs that support stream flow would not be expected to be detectable. The probability of a mine being located within the drainage area of perched springs that support stream flow would be between 0% and 5%. Changes in the quantity of ephemeral stream flow would not be expected to be detectable and would be expected to be limited in extent.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be negligible (as defined above). Surface disturbance would not be located in or adjacent to areas of steep topography; resulting changes in quantity of ephemeral stream flow would be expected to be limited to the immediate vicinity of roadways, exploration sites, and mine sites (as discussed in Section 4.5).
Water Quality	Changes in the concentrations of uranium, or arsenic in surface water supported by springs would not be expected to result in exceedance of estimated ambient concentrations. Changes in the quality of ephemeral runoff would not be expected to result in exceedance of estimated ambient concentrations and would be expected to be limited in extent.	Water quality impacts to perched aquifer or R-aquifer springs that support stream flow would be negligible (as defined above). Distribution of contaminants in soil/sediment and increased erosion would be minor (as defined in Section 4.5) and mining related disturbances would not be located in or adjacent to areas of steep topography; resulting changes in quality of ephemeral stream flow would be expected to be negligible (as defined for R-aquifer springs) and limited to the immediate vicinity of roadways, exploration sites, and mine sites.
Stream Function	Changes in quantity of stream flow and sediment loads would not be expected to result in adverse impacts to overall stream morphology or function.	Surface disturbance or increased erosion and sedimentation, would be minor (as defined in Section 4.5); resulting impacts to runoff and/or stream sedimentation would be expected to be limited to the immediate vicinity of roadways, exploration sites, and mine sites.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Moderate Impact		
Perched Aquifer Springs		
Water Quantity / Quality	Mines could be located within the groundwater drainage area of perched aquifers that support springs. Impact defined by the probability that a perched aquifer spring would have a mine located within its groundwater drainage area. Probability is estimated in accordance with methodology described in Section 4.4.1.	5% to 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates more than an 80% probability that any spring would not be impacted.
Perched Aquifer Wells		
Water Quantity / Quality	New or existing mines could be located within the groundwater drainage area of perched aquifers that support wells. Impact defined by the number of existing and new mines that might impact perched aquifer wells.	Six to 10 mines might impact one well each. Rationale based on North Parcel, where 103 records for existing wells are reported. Ten wells is less than 10% of the existing wells, many of which are likely inactive or abandoned, and 10 mines is about half of the new and existing mines anticipated for the North Parcel under Alternative A.
R-aquifer Springs		
Water Quantity	Changes in the volume of discharge might be detectable, but would not be substantial.	The total anticipated volume of water withdrawn from mine-related R-aquifer wells might be 5% to 10% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations, but would not be expected to result in exceedance of drinking water standards.	At least one mine might contribute impacted water to the R-aquifer, and the resultant concentration of uranium or arsenic might exceed ambient levels, but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic).
R-aquifer Wells		
Water Quantity	Changes in water levels in non-mine R-aquifer wells might be detectable and might have a small adverse effect on the operation of the wells impacted.	Decrease in water levels observed in non-mine R-aquifer wells might range from 10 to 20 feet in the first 5 years of pumping any single mine well. This threshold is up to twice as much as the ADWR criterion for acceptable impact in AMAs.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations but would not be expected to result in exceedance of drinking water standards.	At least one mine might contribute impacted water to the R-aquifer, and the resultant concentration of uranium or arsenic might exceed ambient levels, but would not be expected to exceed drinking water standards (30 µg/L uranium or 10 µg/L arsenic).

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Moderate Impact, continued		
Surface Waters		
Water Quantity	Changes in the volume of discharge from R-aquifer springs that support stream flow might be detectable, but would not be substantial. The probability of a mine being located within the drainage area of perched springs that support stream flow would be between 5% and 20%. Changes in the quantity of ephemeral stream flow might be detectable and might extend beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be moderate (as defined above). Surface disturbance might be located in or adjacent to areas of steep topography and resulting changes in quantity of ephemeral stream flow might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Water Quality	Changes in concentrations of uranium or arsenic in surface water supported by springs might result in exceedance of estimated ambient concentrations, but would not be expected to result in exceedance of drinking water standards. Changes in the quality of ephemeral runoff would not be expected to result in exceedance of estimated ambient concentrations, but might extend beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be moderate (as defined above). Distribution of contaminants in soil/sediment and increased erosion would be moderate (as defined in Section 4.5) and mining related disturbances might be located in or adjacent to areas of steep topography; resulting changes in quality of ephemeral stream flow would be expected to be negligible (as defined for R-aquifer springs), but might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Stream Function	Changes in quantity of stream flow and sediment loads might result in small adverse impacts to overall stream morphology or function.	Surface disturbance or increased erosion and sedimentation would be moderate (as defined in Section 4.5); resulting impacts to runoff and/or stream sedimentation might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Major Impact		
Perched Aquifer Springs		
Water Quantity / Quality	Mines could be located within the groundwater drainage area of perched aquifers that support springs. Impact defined by the probability that a perched aquifer spring would have a mine located within its groundwater drainage area. Probability is estimated in accordance with methodology described in Section 4.4.1.	More than 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates less than an 80% probability that any spring would not be impacted.
Perched Aquifer Wells		
Water Quantity / Quality	New or existing mines could be located within the groundwater drainage area of perched aquifers that support wells. Impact defined by the number of existing and new mines that might impact perched aquifer wells.	More than 10 mines might impact one well each. Rationale based on North Parcel, where 103 records for existing wells are reported. Ten wells is less than 10% of the existing wells, many of which are likely inactive or abandoned, and 10 mines is about half of the new and existing mines anticipated for the North Parcel under Alternative A.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Major Impact, continued		
R-aquifer Springs		
Water Quantity	Changes in the volume of discharge could be detectable and might be substantial.	The total anticipated volume of water withdrawn from mine-related R-aquifer wells might be more than 10% of the estimated aggregate flow from R-aquifer springs located downgradient of mine production wells.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations and drinking water standards.	At least one mine might contribute impacted water to the R-aquifer and the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic).
R-aquifer Wells		
Water Quantity	Changes in water levels in non-mine R-aquifer wells could be detectable and might have a substantial adverse effect on the operation of the wells impacted.	Decrease in water levels observed in non-mine R-aquifer wells might exceed 20 feet of decline in the first 5 years of pumping any single mine well.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations and drinking water standards.	At least one mine might contribute impacted water to the R-aquifer and the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic).
Surface Waters		
Water Quantity	Changes in the volume of discharge from R-aquifer springs that support stream flow could be detectable and might be substantial. The probability of a mine being located within the drainage area of perched springs that support stream flow would be more than 20%. Changes in the quantity of ephemeral stream flow might be detectable and might extend well beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be major (as defined above). Surface disturbance might be located in areas of steep topography and resulting changes in quantity of ephemeral stream flow might extend well beyond the immediate vicinity of roadways, exploration sites, and mine sites (as discussed in Section 4.5).
Water Quality	Changes in concentrations of uranium or arsenic in surface water supported by springs might result in exceedance of estimated ambient concentrations and drinking water standards. Changes in the quality of ephemeral runoff would not be expected to result in exceedance of estimated ambient concentrations, but might extend well beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be major (as defined above). Distribution of contaminants in soil/sediment and increased erosion would be major (as defined in Section 4.5) and mining related disturbances might be located in areas of steep topography; resulting changes in quality of ephemeral stream flow might be moderate to major (as defined for R-aquifer springs), and might extend well beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Stream Function	Changes in quantity of stream flow and sediment loads might result in substantial adverse impacts to overall stream morphology or function.	Surface disturbance or increased erosion and sedimentation would be major (as defined in Section 4.5); resulting impacts to runoff and/or stream sedimentation might extend well beyond the immediate vicinity of roadways, exploration sites, and mine sites.

Table 4.4-2. Water Resource Impact Duration

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

Issues specific to the North and East parcels concern the potential for remote water resource impacts in southern Utah and the Virgin River watershed. The Utah state boundary is near the northeastern edge of the North Parcel. As shown on Figure 3.4-11, surface water drainage over most of the North Parcel is generally toward Kanab Creek and its tributaries, which drain south toward the Colorado River. Surface water in the westernmost part of the North Parcel drains to Clayhole Wash, which is tributary to Fort Pierce Wash (a tributary of the Virgin River), south of St. George, Utah, located about 35 miles northwest of the North Parcel. As described in Section 3.4 (see Figure 3.4-14), R-aquifer groundwater along the western, northwestern, and northeastern margins of the North Parcel is likely to move to the north toward areas in south and central Utah. The R-aquifer dips deeply northward from near the Grand Canyon to thousands of feet in depth (see Figure 3.4-4) and does not directly feed springs along the Virgin River north of the North Parcel (Cordova 1981; Dutson 2005). Only oil and gas wells are known to penetrate to these depths in Utah, where the R-aquifer is not considered a viable drinking water supply.

As described in Section 3.4, the R-aquifer crops out along the Virgin River near Littlefield, Arizona, and upstream in the lower Virgin River gorge in the northwest corner of Arizona (see Figure 3.4-9), about 46 miles northwest from the boundary of the North Parcel. Discharge from springs related to these outcrops has been reported by various sources to range from about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex (personal communication, Don Bills, USGS 2010b). The potential for a hydraulic connection in the R-aquifer between the North Parcel and these spring complexes is not known. Several major north-trending fault zones, including the Sevier, Toroweap, Hurricane, and Main Street faults, occur between the North Parcel and the Virgin River area in northwest Arizona (see Figure 3.4-9). These faults are thought to function like the Mesa Butte Fault Zone south of the Grand Canyon, which provides a preferential pathway where groundwater is intercepted and conveyed along the fault zone to spring systems along the Little Colorado River to the north and the Verde River valley to the south (see Figure 3.4-3). Another example is the West Kaibab Fault Zone (including the Muav and Sinyala faults), which is believed to intercept westward-moving groundwater from the Kaibab Plateau and convey it south and north (see westernmost faults shown on Figure 3.4-15). The fault zones west of the North Parcel, as well as ancient cave systems, likely collect and convey groundwater chiefly north toward central and southern Utah and lesser amounts south toward the Grand Canyon, and they may prevent or limit westward movement of R-aquifer groundwater from the North Parcel across the faults to the Virgin River area in northwest Arizona. In addition, although the R-aquifer and other formations at the north end of the Virgin Mountains are abundantly faulted and fractured, the main body of the north-south-trending crystalline bedrock core of the Virgin Mountains east and southeast from the Littlefield spring complex likely functions as a barrier to east-west groundwater movement. Nonetheless, it is possible that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona. However, if such a connection does occur, the contribution to large spring flow along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small.

A small area (about 2 square miles) of the northernmost extent of the East Parcel lies within the surface water drainage area of the Paria River, which drains a short distance northward into Utah and then returns to Arizona and is tributary to the Colorado River at Lees Ferry. The R-aquifer occurs at depth along the Paria River and does not discharge to the Paria River. R-aquifer groundwater in the small area at the northernmost extent of the East Parcel may move northward into Utah or southward into the main body of the East Parcel. However, similar to groundwater in the North Parcel, any groundwater moving north into Utah is unlikely to discharge at any of the large springs along the Virgin River in southern Utah.

There is no similar potential for remote watershed resource impacts from the South Parcel. All potential impacts would be limited to the Cataract Creek watershed, Little Colorado River watershed, or small watersheds along the South Rim, all of which are local to the South Parcel and tributary to the Grand Canyon watershed.

Rate of groundwater movement in the unsaturated zone and in aquifers is controlled by type of flow regime (fractures, karst, or porous media), permeability and porosity of aquifer and unsaturated zone media, degree of saturation, and hydraulic gradient. These properties vary widely in the rock strata of the Grand Canyon and Virgin River watersheds and provide a wide range of temporal variation in potential impacts. These variations can be characterized but not quantified with the existing data. Geological and hydrologic conditions in the study area are relatively complex in some areas and have received various levels of investigation and data collection. Therefore, the level of uncertainty in hydrologic relationships is relatively high for some locations, whereas such relationships are relatively certain for other locations.

Quantity of Discharge from Perched Aquifer Springs and Wells

SPRINGS

A potential impact to the quantity of water that can discharge from springs fed by perched aquifers is the seepage of groundwater from the source aquifer into mine openings during mining. If the perching layer is re-established from mine reclamation activities, quantity of flow to the spring would gradually approach equilibrium conditions, and the impact might be short term to long term (if several years are required to restore equilibrium conditions). In the event that the perching layer is not re-established after mining, recharge to the aquifer would be expected to continue draining into the mine openings (even if backfilled with waste rock) and deplenishment of the spring might be long term. In the proposed withdrawal area, seeps and springs issue from fractures, bedding planes, or sandstone strata in perched aquifers in the Chinle, Moenkopi, Kaibab, and Toroweap formations, Coconino Sandstone, and Supai Group along the walls and channels of canyons or from outcrops on the plateaus. Springs that issue from rock strata younger than the Chinle Formation do not occur on the parcels and would not be impacted by any of the alternatives; therefore, these springs were not considered in the impact analysis. Similarly, perched aquifer springs that are located outside the parcels and issue from rock strata substantially elevated topographically with respect to correlative strata within the parcels, especially those with bedding that slopes away from the parcels (as occurs north of the North Parcel), would not be impacted and were not considered in the impact analysis. In addition, perched aquifer springs located east of Kanab Creek and south of Snake Gulch (near the North Parcel), east of the Colorado River (near the East Parcel), west of Cataract Creek, or east of the Little Colorado River (near the South Parcel) were not considered because any such springs are hydraulically separated by canyons from potential mining operations on the parcels.

Perched aquifer zones in the proposed withdrawal area are characterized as being commonly small, thin, discontinuous, and generally dependent on annual recharge to sustain yield to springs and wells (Bills et al. 2010; Montgomery et al. 2000). This condition is associated with relatively small groundwater drainage areas and, therefore, requires mining activities to be in relatively close proximity to a perched aquifer spring to present a potential impact. Although the number of perched aquifer springs is low and the reported flow rates are small, the springs support sensitive/unique ecological environments. Perched aquifer conditions are complex and data are generally insufficient to project the degree of potential impact to discharge from a perched aquifer spring that might occur if a mine were located within the groundwater drainage area of the spring. Therefore, potential impact to an individual perched aquifer spring can only be characterized as ranging from none to major, with duration of impact ranging from short term

(1 to 5 years) to long term (greater than 5 years) (defined in Table 4.4-2). However, the probability of a future mine's being located within the groundwater drainage area of a perched aquifer spring can be calculated. The probability can then be assigned an impact threshold with which to evaluate potential impact to perched aquifers under a particular alternative on each parcel. Calculation of the probability requires the following information:

1. the number, location, and flow rates of perched aquifer springs reported for the proposed withdrawal area and non-withdrawal area of each parcel under each alternative (available in Appendix E);
2. the total of the groundwater drainage areas for these springs (estimated);
3. the total non-withdrawal area of each parcel under each alternative (available in Chapter 2); and
4. the total number of anticipated breccia pipe uranium mines within the non-withdrawal area of each parcel under each alternative (available in Appendix B).

As indicated above, except for the groundwater drainage area of the perched aquifer springs, all the necessary information for calculating the probability of impact is available in Chapter 2 and the appendices. For the proposed withdrawal area, data for existing conditions at perched aquifer springs were evaluated to estimate the potential groundwater drainage areas that support the springs. Protective buffer areas were then defined around these springs to establish areas to be considered for withdrawal and to identify potential for effects of mine operations at known sites (Figures 4.4-1, 4.4-2, and 4.4-3).

Although potential impacts to perched aquifer springs from breccia pipe mines might occur rapidly (within a year), such impacts also might not occur for several years and might not be discernible until after a mine has been reclaimed. The potential rate of drainage of perched groundwater to mine openings is controlled by several site-specific factors that are difficult to determine, including recharge, spatial configuration of the perched groundwater zone with respect to location of the mine openings and spring, and hydraulic parameters that affect the rate of groundwater movement. It is not known exactly where future mines might be constructed. Therefore, it is not possible to project the potential rate or degree of depletion of discharge from a spring that might be expected to occur. The impact calculations assume that an eventual impact might occur if a mine is located within the groundwater drainage area of a spring; no estimate of temporal aspects of potential impacts was made.

The groundwater drainage area for each perched aquifer spring was estimated using the following method:

1. The instantaneous flow rate recorded for each spring was used to develop perched aquifer groundwater drainage areas, based on the assumption that discharge at each spring is in equilibrium with recharge to the aquifer. In the event that multiple flow rate measurements or estimates were available, the maximum value recorded was used to provide a conservatively large groundwater drainage area (see Appendix E). Most of the instantaneous discharge measurements reported for perched aquifer springs in the parcels and adjacent areas that might be impacted were 1 gpm or less; therefore, a constant discharge rate of 1 gpm was assumed for all these springs to be conservative. Three perched springs that exceed 1 gpm are located in the North Parcel and were assigned their maximum measured values of 1.1, 1.4, and 5.8 gpm (see Appendix E). Springs that have no reported discharge, or a reported rate of zero, were assigned a discharge rate of 1 gpm because it was assumed that the discharge rate is no greater than the typical reported discharge for other springs in the vicinity. This assumption is considered reasonable because it is likely that distinctly larger flows would have been noted by administering agencies or estimated/noted when the springs were located during surveys conducted by previous investigations.
2. A conservatively small value of 8 inches for average annual precipitation was selected for each parcel, based on the data shown on Figure 3.4-10. The smaller the value for precipitation, the larger the estimated groundwater drainage area for each spring.

3. A recharge rate, as a percentage of precipitation, was selected for each spring area. Metzger (1961) estimated average annual recharge to the principal aquifer in the region (the R-aquifer) to be about 0.3 inch per year (inch/yr), which is about 2% of the average annual precipitation measured at Grand Canyon Village. Montgomery et al. (2000) estimated a recharge rate of about 4% of the average precipitation for the Coconino and San Francisco plateaus based on total groundwater discharge from the principal aquifers. Amount of recharge to the perched aquifer zones has not been estimated; however, it is assumed the average available recharge for the perched aquifers is the same as for the deeper R-aquifer under equilibrium conditions. The smaller recharge value of 2% was selected to provide a conservatively large estimated groundwater drainage area for each perched aquifer spring.
4. The groundwater drainage area for each perched aquifer spring was then calculated using the following equation, which relates the amount of spring discharge to the amount of precipitation and resultant recharge:

$$A = \frac{Q \times C}{R \times P}$$

where:
A = groundwater drainage area, in square miles (mi^2)
Q = discharge at spring, in gpm
C = conversion factor = 0.03 inch-mi^2/gpm-yr
R = recharge as fraction of precipitation, in percent
P = average annual precipitation (inch/yr)

For example, the groundwater drainage area for a 1-gpm spring is calculated as follows:

$$A = \frac{1 \text{ gpm} \times 0.03 \text{ inch-mi}^2\text{/gpm-yr}}{0.02 \times 8 \text{ inch/yr}} = 0.2 \text{ mi}^2$$

After the groundwater drainage areas for the perched aquifer springs have been estimated, the probability of impact can be calculated. The appropriate formula for calculating the probability of impacting a perched aquifer spring in a given parcel under a given alternative is the binomial distribution formula (Kreyszig 1999). This method assumes a random distribution for new mines in the area of consideration, which is appropriate for this analysis. For Alternatives B, C, and D in the North Parcel only, an additional similar calculation was needed to account for the seven anticipated new mines that could be located anywhere on the parcel (see Appendix B), including the withdrawn areas; the two probabilities for each of these alternatives for the North Parcel were then combined by subtracting the product of the probabilities from the sum of the probabilities. Conservative features of this methodology include 1) groundwater drainage areas for many springs were calculated assuming a flow rate of 1 gpm, even though the springs had no flow measurements or flow measured at less than 1 gpm; 2) if any part of the spring drainage area overlapped other springs' drainage areas, the entire estimated drainage area for each spring was considered separately and included in the calculation for probability of impact; and 3) the recharge rate is conservatively calculated.

The binomial distribution formula calculates the probability for results of a series of independent trials when the probability of a single trial is known. In terms relevant to calculating the probability of impact of potential new mine(s) to perched groundwater spring(s), the formula can be written as follows:
$P(I)_k = ({}_mC_k) \times (p_i)^k \times (1-p_i)^{m-k}$ (k can range from 0 to m)

where:

$P(I)$	=	probability of impacting one or more springs after m trials (mines)
${}_mC_k$	=	(m!)/(k!(m-k)!); combination k successes (impacts) in m trials (mines)
p_i	=	probability of success in any one trial (impacting any spring by any one mine); ($p_i = A_{da} / A_{par}$)
A_{da}	=	groundwater drainage area for the perched aquifer springs within the parcel (mi^2)
A_{par}	=	area of the non-withdrawal part of the parcel (mi^2)
m	=	number of trials (number of potential new mines within the allowed area)
k	=	the number of successes in m trials (number of springs impacted by any mines)

To simplify the solution, the formula can be rewritten to calculate the probability of no impact to any spring (no successes in any trials; and k = 0). This approach simplifies the equation to the following:
$P(I) = 1 - (p_{ni})^m$

where: p_{ni} = probability of failure in any one trial (not impacting any spring by any one mine); $p_{ni} = 1 - p_i$

Information required for these calculations is given in Table 4.4-4. For example, in the North Parcel under Alternative D, 17 potential mines are considered; this scenario is more complex than most. Of these, seven of the potential mines could be located anywhere within the entire parcel, while the remaining 10 potential mines could be located only within the non-withdrawal area.

The calculation for probability of impact for this scenario is as follows:

A) Seven mines allowed to be located anywhere within the parcel:
A_{da} = 6.8 mi^2, A_{par} = 859.4 mi^2, p_i = 0.00791, and p_{ni} =0.99209. Therefore,
$P(I) = 1 – (0.99209)^7 = 5.409\%$

B) Ten mines allowed to be located only within the non-withdrawal areas:
A_{da} = 4.1 mi^2, A_{par} = 699.1 mi^2, p_i = 0.00586, and p_{ni} = 0.99414. Therefore,
$P(I) = 1 – (0.99414)^{10} = 5.712\%$

C) To calculate the combined probability for these two cases, subtract the product of the probabilities from the sum of the probabilities:
0.05409 + 0.05712 – (0.05409 x 0.05712) = 10.8%

The shape or orientation of groundwater drainage areas for perched aquifer springs may range widely as a result of weathering and more abundant fractures along canyon rim areas. These parameters are not relevant to the calculation of impact probability because the calculation depends only on the size of the perched aquifer drainage areas. However, the uncertainty in groundwater drainage area shape or orientation was addressed during development of the alternative withdrawal areas by generating protective buffer areas for each mapped spring (see Figures 4.4-1, 4.4-2, and 4.4-3). The protective buffers not only helped delineate the withdrawal areas for Alternatives C and D but also are incorporated into the probability of impact because many of the buffers are included in the total acreage of the alternative withdrawal areas. The protective buffers were generated using the following methodology:

- It was assumed that the length of the groundwater drainage areas might be 10 times the width because all the springs could be fed by an elongated groundwater drainage area associated with a local fracture system. This assumption has the effect of elongating the estimated groundwater drainage area, thereby providing a conservatively large potential impact area for the springs. Solving for such a rectangle with an area of 0.2 square mile (from the equation above) provides a groundwater drainage area length of about 1.4 miles. The length for the three slightly larger springs in the North Parcel was similarly calculated; the length of the groundwater drainage area for the largest perched spring, Clearwater Spring (5.8 gpm), was calculated by this method to be about 3.4 miles. Because the directional orientation of the assumed local fracture system is not known, all directions of the compass were addressed by drawing a circle with a radius equal to the calculated length of groundwater drainage area, centered on each spring. This circle establishes the estimated potential impact area around each of the perched aquifer springs. It was assumed that mine sites within this radius of the springs might impact the quantity (or quality) of discharge from the springs. Using a circle with a radius equal to the largest dimension of the rectangle described above results in a calculated area about 31 times the actual area of the rectangle. Therefore, each protective buffer is conservatively large, which accounts for significant uncertainties in the actual shapes or orientations of groundwater drainage areas for perched aquifer springs.

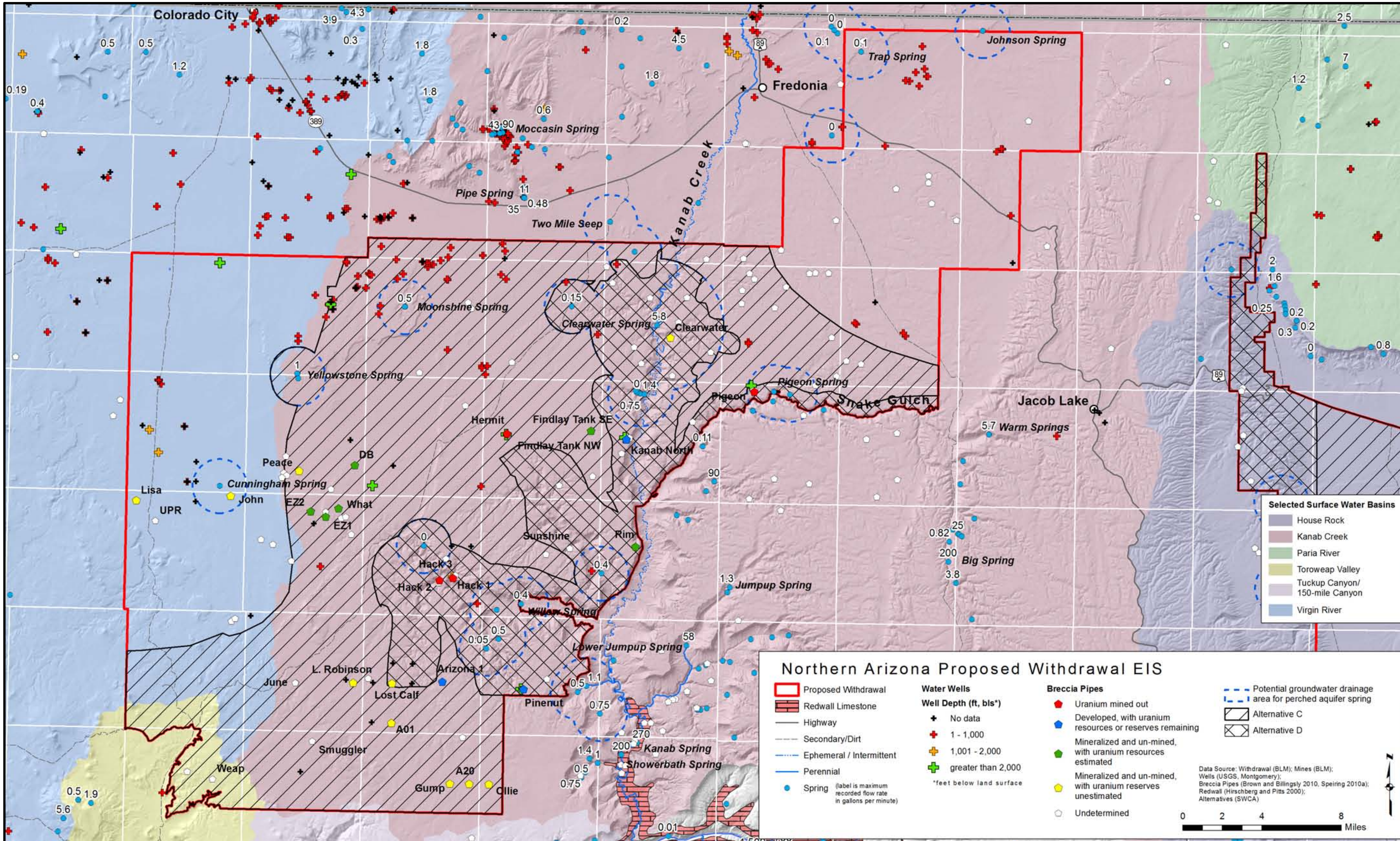

Figure 4.4-1. North Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

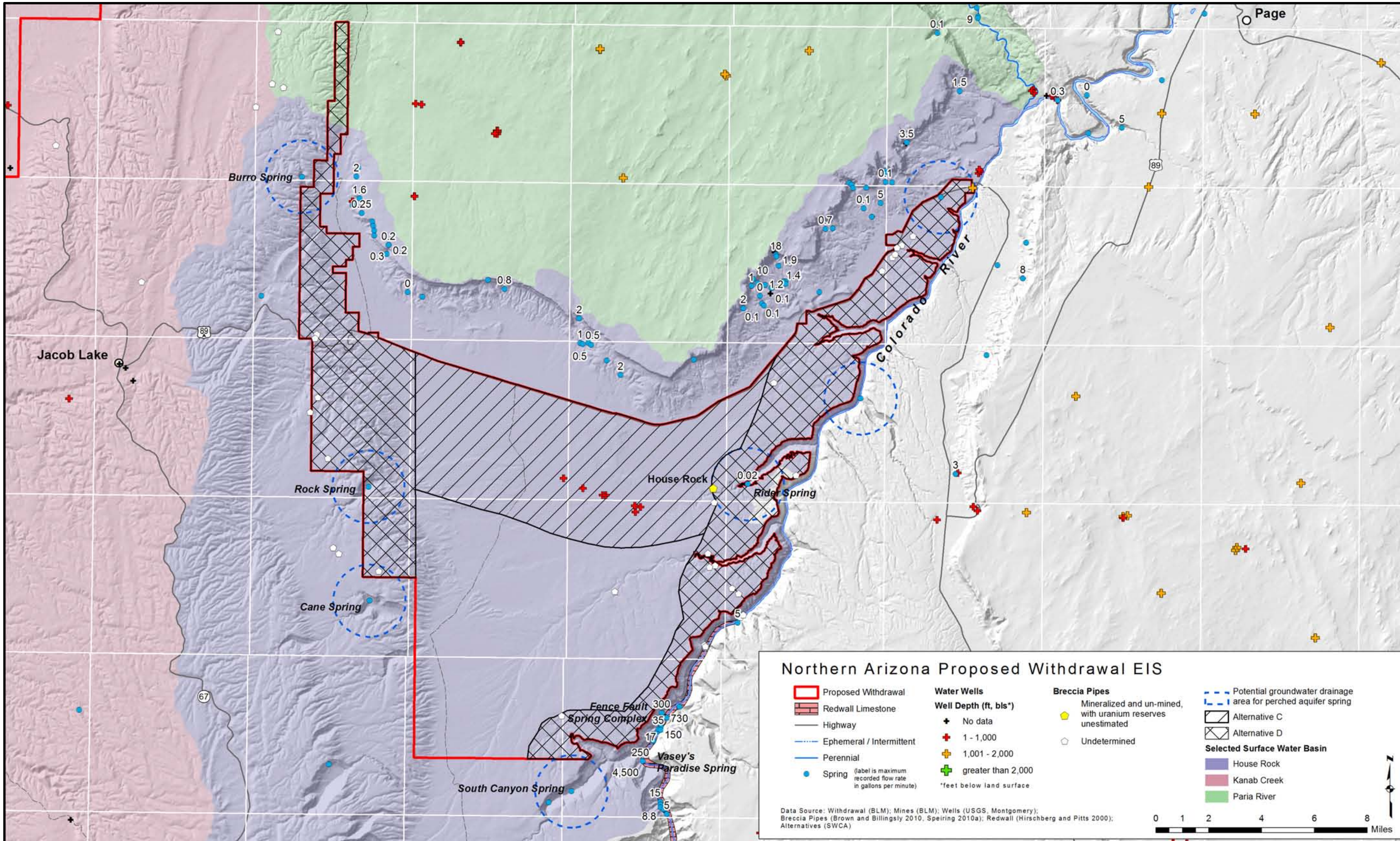

Figure 4.4-2. East Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

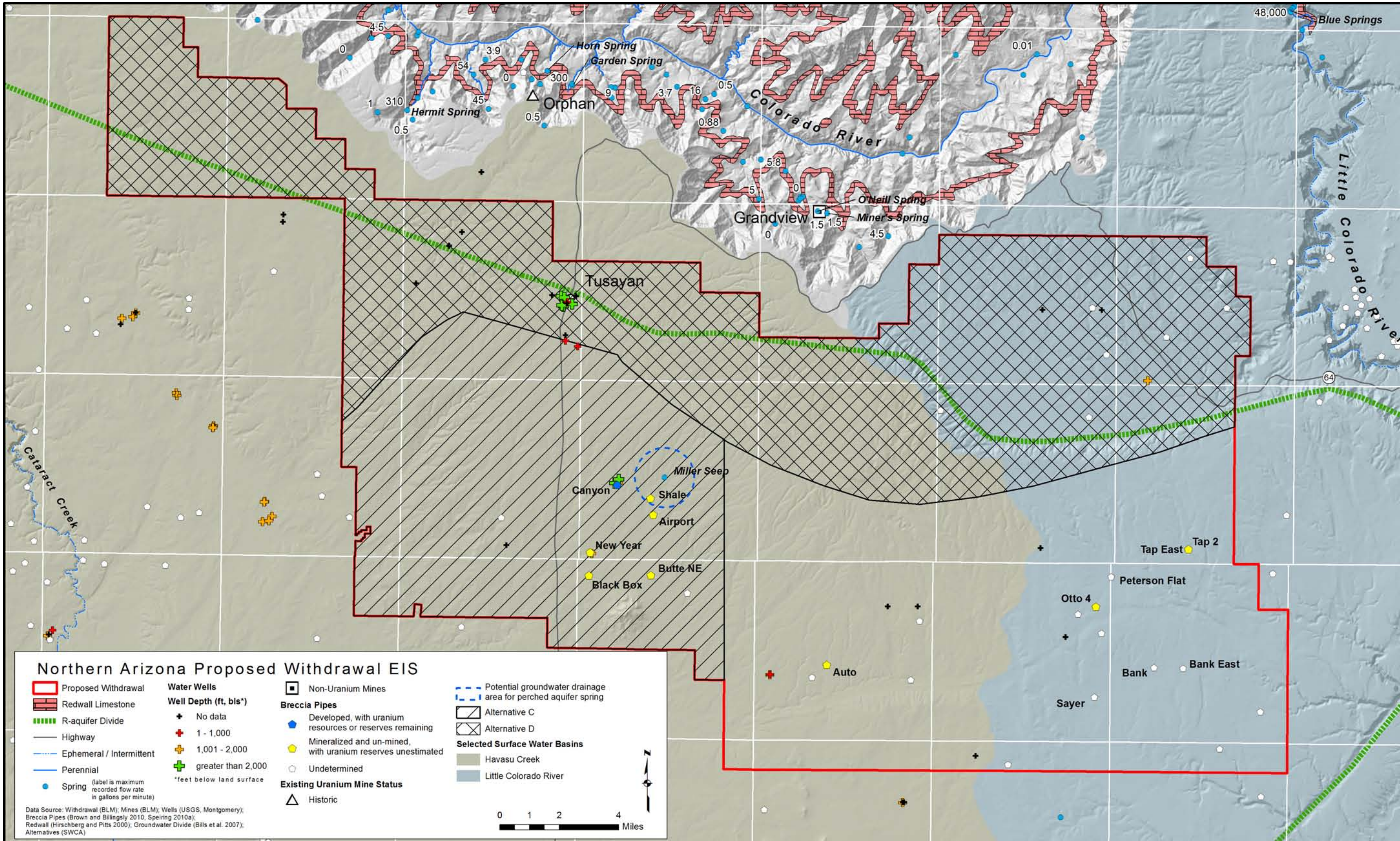

Figure 4.4-3. South Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

WELLS

Perched aquifer wells may pump perched groundwater at various rates determined by the well and pump capacity, the perched aquifer permeability and volume of groundwater in storage, depth to groundwater, and water demand and pumping schedule of the well user. Unlike a spring, the well yield is not directly related to the groundwater drainage area of the perched groundwater zone or the annual recharge to that zone. Although these factors ultimately limit the amount of groundwater that a well can pump from storage in the perched aquifer, they cannot be estimated in the same inflow-outflow manner described in the previous discussion for perched aquifer springs because the outflow point (the well) is not a natural part of the flow system and well discharge rate does not depend directly on perched aquifer recharge. In addition, because the perched groundwater zones are small and discontinuous, it is not possible with available data to estimate their location and extent where they do not have numerous wells or a natural drainage point such as a spring. Furthermore, wells can potentially be located anywhere and to any depth in the future, and data for pumping rate, aquifer hydraulic properties, and chemical quality of most wells are not required to be reported or are not available in the parcel areas. Therefore, it is not possible to reasonably calculate or locate protective buffer areas or groundwater drainage areas for perched aquifer wells, as was done for perched aquifer springs. It is assumed that breccia pipe uranium mine openings near perched aquifer wells might impact both the quantity and chemical quality of discharge from the wells in a manner similar to the impacts that might occur to perched aquifer springs and that potential impacts on any particular well could range from none to major and have a duration ranging from short term to long term. Potential impact to perched aquifer wells under each alternative on each parcel was defined by the number of existing and new mines that might impact perched aquifer wells in accordance with Table 4.4-1.

Well records (see Appendix D) indicate that, of the 103 records reported for wells drilled shallower than the R-aquifer in the North Parcel, only five of the non-mineral-exploration wells were drilled in the past 20 years. Of the seven wells reported for the East Parcel, none were drilled in the past 38 years. Of the 16 records reported for wells drilled shallower than the R-aquifer in the South Parcel, none of the non-mineral-exploration wells were drilled in the past 42 years. Many of the recorded wells are likely either unused or abandoned. Where no date for a non-mineral-exploration well is given, it was assumed that the well was drilled prior to the 1980 Groundwater Management Act or that the well was not actually drilled. In addition, livestock grazing operations on the parcels have declined over the past few decades, the number of quarries and sand and gravel operations is not expected to increase significantly over the next 20 years, and a substantial permitting process is required to install new wells on federal lands. Based on this information, the number of new perched aquifer water wells anticipated to be drilled in the parcels over the next 20 years is none to few.

Deep mineral exploration boreholes and R-aquifer water supply wells for the mines might provide potential conduits for movement of groundwater from perched aquifers to deeper formations. However, AAC Title 12, Chapter 15, Article 8 requires proper construction and abandonment of wells to prevent cross-contamination of different aquifers. The following excerpts from Article 8 are pertinent to definition, applicability, and restrictions on exploration and water wells:

> **R12-15-801.13:** "Exploration well" means a well drilled in search of geophysical, mineralogical, or geotechnical data.
>
> **R12-15-802:** This Article shall apply to man-made openings in the earth through which water may be withdrawn or obtained from beneath the surface of the earth, including all water wells, monitor wells and piezometer wells. It shall also apply to geothermal wells to the extent provided by ARS 45-591.01, and all exploration wells and grounding or cathodic protection holes greater than 100 feet in depth. (This Article shall not apply to R12-15-802.4: Drilled boreholes in the earth less than 100 feet in depth, which are made for purposes other than withdrawing or encountering groundwater, such as exploration wells and grounding or cathodic protection holes;

except that in the event that groundwater is encountered in the drilling of a borehole, this Article shall apply.)

R12-15-811.B.1: [Surface Seal] Except as provided in subsections (2) and (4) of this subsection, and R12-15-817(B)(1), all wells shall be constructed with a surface seal as herein provided. The seal shall consist of steel casing, one foot of which shall extend above ground level, and cement grout placed in one continuous application from the bottom of the zone to be grouted to the land surface. If a pitless adaptor is utilized, the cement grout may terminate at the bottom of the pitless adaptor. The minimum length of the steel casing shall be 20 feet. The minimum annular space between the casing and the borehole for placement of grout shall be one and one-half inches. Curing additives, such as calcium chloride, shall not exceed ten percent of the total volume of grout. Bentonite as an additive shall not exceed five percent of the total volume. The minimum length of the surface seal shall be 20 feet. Any annular space between the outer casing and an inner casing shall be completely sealed to prevent contamination of the well.

R12-15-811.F.3: [Fluids and Solids Control] Drilling fluids and cuttings shall be contained in a manner which prevents discharge into any surface water.

R12-15-812.B: [Cross Contamination] Mineralized or polluted water. In all water-bearing geologic units containing mineralized or polluted water as indicated by available data, the borehole shall be cased and grouted so that contamination of the overlying or underlying groundwater zones will not occur.

R12-15-816.G: [Abandonment] The abandonment of a well shall be accomplished through filling or sealing the well so as to prevent the well, including the annular space outside the casing, from being a channel allowing the vertical movement of water.
R12-15-816.I.1: [Abandonment] A well penetrating a single aquifer system with no vertical flow components shall be filled with cement grout, concrete, bentonite drilling muds, clean sand with bentonite, or cuttings from the well.

R12-15-816.I.2: [Abandonment] A well penetrating a single or multiple aquifer system with vertical flow components shall be sealed with cement grout or a column of bentonite drilling mud of sufficient volume, density, and viscosity to prevent fluid communication between aquifers.

R12-15-817.B.1: [Construction and Abandonment] If an exploration well which is to be left open for re-entry at a later date encounters groundwater, it shall be cased and capped in accordance with R12-15-811, R12-15-812, and R12-15-822.

R12-15-817.B.2: [Construction and Abandonment] Exploration wells not left open for re-entry shall be abandoned in accordance with R12-15-816.

For the purposes of this EIS, it is assumed that mines comply with all applicable state and federal regulations. Therefore, because the regulations are protective of groundwater, deep drilling operations that occurred after the regulations were adopted on March 5, 1984 (ADWR 2008), are considered to represent no impact or a negligible impact to the quantity and quality of perched groundwater available to perched aquifer springs or wells. Duration of the negligible impact would likely range from temporary to short term (see Table 4.4-2).

Exploration wells drilled prior to March 5, 1984, might not necessarily meet the assumption of proper abandonment used for discussion of direct and indirect impacts. However, it is assumed that the pre-1984, pre-regulation wells represent a negligible impact because 1) the typical borehole is 6 inches in diameter, whereas mine openings can be 150 feet or more in diameter, so that if the well encountered ore, the surface area available for dissolving minerals is limited; 2) the mineral deposits typically encountered by exploration drilling would be much less disturbed than exposed mineralized deposits inside the mine, which would also limit the surface area available for dissolving minerals; and 3) wells drilled prior to

1984 were typically drilled using low-permeability bentonite clays as a drilling fluid additive, which would be expected to provide a seal. Duration of the negligible impact would likely range from temporary to long term (defined in Table 4.4-2).

ADWR records indicate that, for all but one of the existing and abandoned mine water supply wells completed in the R-aquifer, the well annulus is sealed with cement at casing reduction points, thereby preventing water from moving down the wellbore via the annulus between the borehole wall and the casing. Although not sealed during operation, the Hack Canyon Complex well was abandoned by filling with cement. The Pigeon Mine well was also abandoned by filling with cement (personal communication, Roger Smith, formerly with Energy Nuclear Fuels, Inc. 2010).

Existing wells of record (see Appendix D) that are not reported to be abandoned or cancelled (not drilled) are shown in Figures 3.4-9, 3.4-11, 3.4-12, and 3.4-13. However, for the following reasons, the wells shown may not be an accurate representation of all water wells in each parcel that could be subject to impact:

1. Errors in well registration may have resulted in some records that do not clearly report status or well type (i.e., some wells may not actually be water wells, or may have never been drilled, or may have been abandoned).
2. Some “pre-code wells” (wells drilled prior to establishment of the Arizona Groundwater Code) may have never been registered and are not in the ADWR databases.
3. Some wells may be damaged or have malfunctioning pump equipment that cannot be removed, thereby rendering the wells unusable.
4. Some wells may be dry.

Chemical Quality of Perched Aquifer Springs and Wells

In some mineralized breccia pipes, ore targeted for mining may occur in or above perched groundwater zones, as well as below. In these cases, there might be the potential for mining operations to impact the chemical quality of the perched groundwater by causing oxidation and mobilization of chemical constituents in exposed residual ore and waste rock remaining in the mine after reclamation. The inward dip of bedding in rock units adjacent to the breccia pipes is thought to induce local inward flow of perched groundwater toward the pipe. If the perching layer is re-established during mine reclamation, replenishment of perched groundwater in the pipe depression might occur over time, and groundwater flow paths, locally influenced by bedding orientations near the pipe, might intersect the old mine workings, where trace elements might be mobilized and transported toward points of discharge from the aquifer. Therefore, mines located within the groundwater drainage area of a nearby perched aquifer spring or well might impact the chemical quality of discharge at the spring or well. Water quality impacts to perched springs or wells would not be expected to occur during mining or if the perching layer is not re-established because the mine openings would be expected to drain the perched aquifer, and movement of mine contaminants to the spring or well would not be possible.

The probability of an impact to water quality at a perched aquifer spring is considered to be the same as the probability of an impact to the quantity of water at the spring, which was discussed previously and is defined in Table 4.4-1. Accordingly, the same methodology established for quantity of discharge from the perched aquifer springs is applicable to estimating the potential for impact on chemical quality of the perched springs. For the reasons described in the preceding discussion, it is not possible to reasonably calculate or locate protective buffer areas or groundwater drainage areas for perched aquifer wells. However, as with springs, the potential magnitude of impact to water quality at a particular perched aquifer well is considered the same as the potential magnitude of impact to water quantity at the well, as defined in Table 4.4-1.

Because the reported discharge rates are small for the perched aquifer springs located in the parcels, there is little opportunity for dilution to attenuate such impacts. Therefore, if an impact were to occur, it could be major. The same relations generally apply for perched aquifer wells. Therefore, potential impact to water quality at an individual perched aquifer spring or well can only be characterized as ranging from none to major, with duration of impact ranging from short term to long term (defined in Table 4.4-2). However, the potential for impact on perched aquifer springs under each alternative in each parcel is evaluated using the probability method described previously.

Discharge from Regional R-Aquifer Springs and Wells

SPRINGS

Although the base of typical mine openings would be more than 1,000 feet above groundwater in the regional R-aquifer system, deep groundwater supply wells would likely be constructed at many of the mine sites to provide water from the R-aquifer for mine operations. Potential yield of groundwater to wells constructed in perched aquifers is small and typically unreliable; therefore, the regional R-aquifer is the most likely source of well water for the mines, and most of the existing and historic breccia pipe uranium mines have or had these wells. Depending on well location, amount of pumping, and the magnitude of spring discharge, groundwater withdrawal from the R-aquifer could potentially reduce the discharge from R-aquifer springs. To assess these impacts, the projected mine water use given in Appendix B was compared with the discharge from R-aquifer spring systems that might be impacted. A value of 5% of the aggregate reported spring discharge was used as a threshold for impact determination because it is less than the minimum probable uncertainty in typical stream flow measurements reported by Harmel et al. (2006). This amount of decrease would also likely be less than or within the natural variation of spring flow for those springs.

WELLS

The only existing non-mine R-aquifer wells within the parcels are three wells located at Tusayan on the South Parcel (see Table 3.4-1, Figure 3.4-13). These wells provide an important source of public drinking water to the community of Tusayan. It is possible that the small population centers at Tusayan and to the south at Valle might drill additional R-aquifer production wells to meet increases in demand for public water supply. As described in Section 4.4.4, R-aquifer Wells Quantity, under Alternative A, no new non-mine R-aquifer wells are projected to be drilled on or near the North and East parcels for the 20-year period of this analysis.

The potential water level drawdown in the R-aquifer from the use of mine wells as described in Appendix B can be projected using the methods and aquifer hydraulic properties described for the computer-based groundwater flow model of the Coconino Plateau constructed by Montgomery (1999) for the Tusayan Growth EIS. Using this method, drawdown was projected for a well pumping 5 gpm continuously for 4 years.[13] Results indicate that the 5-foot water level drawdown contour could extend about 270 feet from the mine well in relatively unfractured aquifer areas and much less than 1 foot from the well in major fault zones. Although this analysis carries uncertainty, and actual drawdown could vary, depending on site-specific conditions, these results suggest that the off-mine-site drawdown caused by mine wells is expected to be small and that recovery of water levels is expected to be rapid after pumping stopped. The projected water level drawdown can be compared to the criterion used by the ADWR for acceptable well impact in Active Management Areas (AMAs). The criterion for acceptable water level

[13] Aquifer hydraulic properties used from Montgomery (1999) include transmissivity ranging from 1,000 gpd/foot for relatively unfractured areas to 400,000 gpd/foot for major fault systems; storage coefficient ranging from 0.001 for relatively unfractured areas to 0.005 for major fault systems; average aquifer saturated thickness of 600 feet; and both confined and unconfined aquifer conditions.

drawdown impact caused by one well to a nearby well is less than 10 feet in the first 5 years of pumping. Based on the location of existing wells and the projected construction of new wells, it is not likely that mines would be located sufficiently near a non-mine R-aquifer water supply well to cause more than a negligible water level drawdown impact to the non-mine well, according to the criteria given in Table 4.4-1. Because it is anticipated that no more than six mines would be in operation at any one time (see Appendix B, Section B.8.1.7), the potential total drawdown impact to existing wells at Tusayan, Valle, or more distant areas from pumping mine wells would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of the negligible impact would likely range from short term to long term (defined in Table 4.4-2).

Chemical Quality of Regional R-Aquifer Springs and Wells

The principal mine-related constituent of concern for water quality in the parcels and surrounding regions is uranium. Other trace elements reported to be associated with uranium in mineralized breccia pipes include antimony, arsenic, barium, cadmium, cobalt, copper, lead, molybdenum, nickel, silver, strontium, vanadium, and zinc (Wenrich et al. 1994). However, not all of these constituents necessarily correlate with dissolved uranium in water. Bills et al. (2010) evaluated historic water quality data compiled for the region to identify exceedances of drinking water standards and health-based guidance levels for the following additional constituents of concern: arsenic, lead, mercury, and molybdenum. The following uranium-series decay products were identified by Hinck et al. (2010) to present a potential hazard to fish and wildlife in the area if present in the environment: uranium, thallium, thorium, bismuth, radium, radon, protactinium, polonium, actinium, and francium. Unfortunately, very few data exist for these radionuclides and metals (other than uranium and arsenic) in the study area; therefore, uranium and arsenic data must be used as a proxy for assessing potential levels of metals and decay-chain products. Hinck et al. (2010) report uranium concentration guidance values that are for protective limits for various species in the region as ranging from 2.6 to 69,000 μg/L.

SPRINGS

It is important to acknowledge that the travel time for some impacts to wells and springs may be longer than the time that has passed since uranium mining began in the North Parcel. It is also important to recognize that, based on the information described in Section 3.4, there is currently no conclusive evidence from well and spring sampling data that breccia pipe uranium mining operations in the North Parcel have impacted the chemical quality of groundwater in the regional R-aquifer. As described in Section 3.4.4, the low permeability conditions associated with ore deposits in the breccia pipes and adjacent rock strata between the base of mine openings and R-aquifer are thought to retard the downward movement of any perched groundwater drainage into the mines and, therefore, are not favorable for downward migration of dissolved minerals from the mine openings. These conditions result in low risk of impacts to the R-aquifer and support the assumption that it is entirely possible for there to be no impact to R-aquifer water quality. However, as described in Section 3.4.4, hydrogeologic conditions at individual breccia pipes may vary, which introduces uncertainty into the impact analysis. For example, the Orphan Lode Mine is located at the South Rim of the Grand Canyon, where the entire section of rock units from the Kaibab Formation to the base of the R-aquifer is exposed and subject to weathering and near-rim fracture enhancement. These conditions are not expected to occur along the shallower tributary canyons of the North Parcel, as demonstrated by conditions encountered in the Hack Canyon Complex, Kanab North, and Pigeon mines. However, such conditions might be expected along the west rim of Marble Canyon, which borders the eastern boundary of the East Parcel. If an impact to R-aquifer water quality were to occur, the potential magnitude is addressed by the methodology and assumptions given below.

The Orphan Lode Mine, located north of the South Parcel, is the only closed and unreclaimed breccia pipe uranium mine where impacts on chemical quality of perched groundwater draining through the mine down to R-aquifer strata have been documented (Liebe 2003; see also Section 3.4.7 and Appendix G). In addition, the Orphan Lode Mine is located only about 0.5 mile from the location where samples collected by Liebe (2003) showed high concentrations of mine-related dissolved uranium in groundwater. Because the Liebe (2003) samples were taken so near the mine, the samples do not show the effects of dilution and attenuation from movement through the aquifer that would occur at other springs of concern. Therefore, the Liebe (2003) results are considered to represent a condition where the mine drainage has recently entered the aquifer and has not traveled far. Although the Orphan Lode Mine is a singularly poor example of post-mining practices, current and future mines, even with improved mining practices, will still be required to address risks of potential groundwater contamination similar to that associated with the Orphan Lode Mine. Although possibly not a worst-case scenario, the USGS believes that the Horn Creek data represent the upper end of potential contamination that will be required to be addressed and the types and amounts of uranium potentially released to the environment (personal communication, D. Bills, USGS 2011).

An assessment using conservative assumptions was conducted to ascertain potential impacts if mine drainage were to reach the R-aquifer and migrate to points of natural discharge from the aquifer. Assumptions for this assessment include the following:

- From none to one-half the number of mines predicted for each parcel in the RFD scenarios (see Table B-43, Appendix B) would continue to drain 1 gpm through the mine for the 20-year period of this EIS analysis. No data were available to determine the number of new mines that might both receive continuous drainage from a perched aquifer and contribute contaminated water to the R-aquifer by migration through low-permeable formations underlying the mine openings. Given the fact that this occurrence is not likely based on known and expected conditions, it is reasonable to assume that no more than 50% of all mines would ever contribute contaminated water to the R-aquifer. It is entirely possible that none of the mines projected to be developed in the RFD scenarios would contribute contaminated water to the R-aquifer. Thus, the assumption of none to one-half of all new mines contributing contaminated water to the R-aquifer accounts for uncertainty of hydrogeologic conditions at new mine sites and allows for projections of potential impacts that are both reasonably foreseeable and conservatively high. The assumption of a long-term continuous groundwater drainage of 1 gpm from the perched aquifer system penetrated by mine openings is also conservative because it exceeds the conditions historically encountered in the existing and reclaimed breccia pipe mines on the North Parcel (see Section 3.4.4). Further, most of the perched aquifer springs that have been measured or estimated on the North, East, and South parcels discharge 1 gpm or less.
- The potential drainage from these mines could contain dissolved uranium concentrations of up to 400 µg/L (see Appendix G) when it reaches the R-aquifer, which is the highest concentration detected in water samples obtained directly below the Orphan Lode Mine (Liebe 2003). Even though the near-rim and unreclaimed conditions at the Orphan Lode Mine are not considered to be comparable to conditions at existing and historic breccia pipe uranium mines on the North Parcel, as described in Chapter 3, chemical analyses reported by Liebe (2003) are the only data available for water that moved through an unreclaimed breccia pipe uranium mine after mining operations had ceased.
    - The highest concentration of dissolved uranium detected in the sump of the Hermit Mine during mining operations was 36,600 µg/L (see Appendix G); however, this value probably represents concentrations in water that has moved over fresh high-grade exposures of unmined uranium ore as well as being exposed to uranium dust in haulage tunnels and other conditions that tend to increase concentrations in an active mine. The sump water is pumped out to the evaporation pond at land surface during mining operations. After the sites are mined out and mine reclamation is complete, the waste rock and small amount of residual ore would continue to provide a lesser source of uranium and other metals if perched groundwater were to continue to move through the

mine. None of the studies conducted for water quality at the R-aquifer mine wells on the North Parcel, one of which included periodic sampling data for up to 9 years after completion of mining activities (Hermit Mine well), concluded that uranium mining activities have affected the R-aquifer. Based on their 2009 water quality sampling study, which included sampling of the Pinenut and Canyon mine wells, Bills et al. (2010) concluded that relationships between the occurrence of dissolved uranium and 13 other trace elements and mining activities were few and inconclusive. Therefore, the concentrations in the Hermit Mine sump were not considered representative for post-mining drainage at mines in the proposed withdrawal area, nor would similar concentrations be expected in R-aquifer groundwater. The water samples obtained by Liebe (2003) below the Orphan Lode Mine provide the only example available of water that has been demonstrated to be affected by mine drainage (see isotope evaluation in subsection of Section 3.4.7 titled Legacy Impacts to Water from Uranium Mining) and that has been exposed to attenuating processes of dilution and adsorption/absorption in the fine-grained rock units between the mine openings and the R-aquifer but has likely not experienced significant attenuation and dilution during transport in the aquifer as a result of the relatively close proximity of the mine to the spring system.

  - The water samples reported by Liebe (2003) were not analyzed for arsenic and cannot be used to provide a similar estimate for constituent concentrations in groundwater impacted by mine drainage. Therefore, to assess the potential impacts for arsenic, the arsenic value of 90 µg/L detected for a water sample obtained inside the Orphan Lode Mine (Hom 1986) was assumed for the potential mine drainage for this assessment.

- The potential mine drainage is not affected by attenuation or dilution in the aquifer during transport and is only modified by instantaneous mixing with the volume of water discharging at the R-aquifer spring system for the basin analyzed. Thus, a significant aspect of dilution is taken into account because the assumed concentration in the hypothetical mine drainage is mixed with all of the water discharging at the spring that is derived from a certain groundwater sub-basin. However, sufficient data are not available for the aquifer system or the potential locations for future mines to adequately characterize all the possible flow paths and dilution/attenuation rates for groundwater movement in the R-aquifer. It is likely that the route for contaminant transport would be comprise multiple segments with different travel times within the aquifer and that dilution and attenuation would vary, depending on interaction of the potential mine drainage with various rock particles and variably saturated pore spaces. If flow via fractures is the primary path the potential mine drainage would follow, then discounting additional attenuation described above would be more representative for actual conditions. However, as described in Section 3.4.4, such fracture paths are unlikely at economically viable breccia pipe uranium deposits; thus, calculated concentrations would be expected to be conservatively high. Many alternative contaminant pathway scenarios can be contemplated making different assumptions; however, the conservative assumption of no attenuation or dilution accounts for a wide range of pathways and flow mechanisms, resulting in a wide range of projected potential impacts.

The indicator threshold values used for chemical quality in this impact assessment were the EPA drinking water MCLs for total dissolved uranium (30 µg/L) and arsenic (10 µg/L) (EPA 2009). The EPA has established National Primary Drinking Water Regulations that set mandatory water quality standards for public water supplies. These are enforceable standards called MCLs, which are established to protect the public against consumption of drinking water contaminants that present a risk to human health. An MCL is the maximum allowable amount of a contaminant in drinking water that is delivered to the consumer. MCLs for uranium and arsenic are established to protect consumers from the cumulative effects of long-term daily use; a concentration slightly in excess of an MCL for these compounds represents a relatively low level of risk. Incidental use of these springs by backcountry hikers or river enthusiasts would be expected to represent a negligible risk to human health unless MCLs are exceeded by a large amount.

With the possible exception of Havasu Springs, the regulatory aspect of MCLs does not apply to the springs in the area that might be impacted because these springs are not regulated as public water supplies. MCLs are used in the impact analysis only as indicator criteria for quantifying potential impacts. Indicator threshold values used for assessment of potential chemical and radiation toxicity impacts on aquatic and terrestrial biota, including those given in Table 6 of Hinck et al. (2010), are discussed in Section 4.7, Fish and Wildlife.

An example of the methodology is given by the assessment for dissolved uranium concentrations projected for Alternative A at the Havasu Springs complex, which is the point of discharge for the Cataract Creek groundwater basin that drains most of the South Parcel (see discussion in Section 3.4). The assumptions and calculations include the following:

1. Zero to about half (four) of the seven mines predicted for the South Parcel might contribute 1 gpm of water containing 400 µg/L of dissolved uranium to the R-aquifer. It is assumed that zero to four of these mines would occur in the Havasu Springs groundwater drainage basin. It is assumed that this contribution of impacted water would reach the Havasu Springs system undiminished, mixing instantaneously with the average discharge of 29,000 gpm.
2. The average ambient concentration of dissolved uranium is about 6 µg/L in the discharge from Havasu Springs, based on monitoring data (see Appendix G).
3. The mass flux of dissolved uranium in the hypothetical mine drainage is calculated using the following equation:

$$\Phi_{mine} = n \times C_{mine} \times Q_{mine} \times K$$

   where: Φ_{mine} = uranium mass flux in mine drainage, in micrograms per minute (µg/min)

   n = number of mines contributing impacted water to R-aquifer

   C_{mine} = concentration of dissolved uranium in contribution of impacted water, in µg/L

   Q_{mine} = rate of drainage of impacted water from mine, in gpm

   K = conversion factor = 3.79 liters (L) per gallon

   The example calculation would be:

   Φ_{mine} = 4 mines × 400 µg/L × 1 gpm × 3.79 = 6,000 µg/min (rounded to significant digits)

4. The mass flux of dissolved uranium at Havasu Springs is calculated using the following equation:

$$\Phi_{spring} = C_{spring} \times Q_{spring} \times K$$

   where: Φ_{spring} = uranium mass flux at Havasu Springs, in µg/min

   C_{spring} = concentration of dissolved uranium in the spring discharge, in µg/L

   Q_{spring} = discharge rate of Havasu Springs, in gpm

   The example calculation would be:

   Φ_{spring} = 6 µg/L × 29,000 gpm × 3.79 = 700,000 µg/min (rounded)

5. The resulting potential concentration due to the addition of mine drainage (C_{result}) of dissolved uranium at Havasu Springs is then calculated using the following equation, which divides the total mass flux ($\Phi_{spring} + \Phi_{mine}$) by the total flow rate (Q_{spring} + [n × Q_{mine}]):

$$C_{result} = \frac{\Phi_{spring} + \Phi_{mine}}{(Q_{spring} + [n \times Q_{mine}]) \times K}$$

where: Φ_{spring} = uranium mass flux at Havasu Springs, in µg/min
C_{spring} = concentration of dissolved uranium in the spring discharge, in µg/L
Q_{spring} = discharge rate of Havasu Springs, in gpm

The example calculation would be:

$$C_{result} = \frac{700{,}000\ \mu g/min + 6{,}000\ \mu g/min}{(29{,}000\ gpm + [4\ mines \times 1\ gpm]) \times 3.79} = 6\ \mu g/L\ (rounded)$$

This concentration, rounded to the nearest significant digit to show level of accuracy, is equal to the ambient (average) concentration of dissolved uranium at Havasu Springs. The assumption of zero mines contributing impacted water to the R-aquifer would produce a projected concentration of 0 µg/L contributed by mines. These concentrations would be considered to represent a range from no impact to a negligible impact, according to the criteria given in Table 4.4-1. The range of calculated mine-related contributions of 0 µg/L to the ambient level of 6 µg/L for dissolved uranium can then be compared with the following threshold values:

- EPA drinking water MCL for dissolved uranium of 30 µg/L, based on human consumption
- Examples of protective guidance values for dissolved uranium for exposed aquatic and terrestrial biota given in Table 6 of Hinck et al. (2010) include the following:
  - 457 to 6,915 µg/L — Range based on all aquatic life uses for Arizona, Colorado, New Mexico, and Utah
  - 3.5 µg/L — Arizona Water Quality Criteria for aquatic life
  - 2.6 µg/L — Chronic Tier II threshold for aquatic life
  - 7,000 µg/L — No adverse effect level wild-mammal benchmark based on drinking water for white tailed deer
  - 69,000 µg/L — Lowest adverse effect level benchmark based on drinking water for rough winged swallow

Guidance values for biota are defined, compared, and applied in the impact analysis given in Section 4.7, Fish and Wildlife.

Although the calculation of potential changes in the ambient or average concentrations at individual springs or spring complexes is used to quantify potential impacts, each individual spring may exhibit variations in natural concentrations owing to seasonal variations in flow or different discharge points in a complex. Thus, the range of projected impacts to the ambient concentration at each spring should also be considered, relative to the minimum and maximum reported concentrations for each spring. The range of reported concentrations for each spring or spring complex is provided in Table 4.4-5.

WELLS

The R-aquifer wells at Tusayan are located along the Vishnu Fault zone, which caused abundant fracturing of the R-aquifer and overlying strata. This fault zone constitutes a southwest-trending, linear, high-permeability feature in the aquifer in the South Parcel. Based on the groundwater flow modeling conducted for the Coconino Plateau by Montgomery (1999), pumping of the R-aquifer wells at Tusayan would be expected to create an elongate area oriented along the associated fault zone that would yield groundwater to the wells. This area is often referred to as the capture zone of the wells. The exact shape and extent of the capture zone is uncertain; however, based on the modeling results, the capture zone would be expected to extend a relatively short distance (estimated to be 1 to 2 miles) from the wells to the southwest along the fault. Southwest, or downgradient, of that capture zone extent, groundwater in the R-aquifer would be expected to move downgradient along various flow paths toward the Havasu Springs complex and not be captured by the Tusayan wells. If mine drainage were to occur from a breccia pipe uranium mine within this capture zone and, although it is unlikely, if the mine drainage were to reach the R-aquifer and not be mitigated, it would be possible for the mine drainage to eventually become part of the groundwater yielded to the Tusayan wells at a highly diluted concentration. The R-aquifer wells downgradient to the south in Valle likely yield groundwater that is partly from the R-aquifer beneath the South Parcel. The Valle wells could similarly yield groundwater affected by mine drainage if the conditions described above were to occur. These conditions could affect any new R-aquifer wells installed in the parcels or adjacent areas if located downgradient of or sufficiently near a breccia pipe mine and if the conditions described above were to occur. Although possible, these impacts are not considered likely because of the removal of contaminated sump water during mining, reclamation of the mines, monitoring, and the low permeability conditions that typically occur in the breccia pipe and in the hundreds of feet of intervening rock formation between the aquifer and the mine openings. Because data are insufficient to estimate the specific flow paths and dilution in the aquifer at future mines, it is not possible to quantitatively project the potential impacts to chemical quality at non-mine R-aquifer wells, if such impact were to occur. Therefore, it is assumed that the potential impact would range from none to major. Duration of the impact would likely be long term (defined in Table 4.4-2). As described in a preceding part of Section 4.4.1 on perched aquifer wells, it is assumed that the state and federal regulations for drilling exploration wells and water wells have been and are being met; therefore, deep drilling operations are projected to represent no impact or a negligible impact to R-aquifer water quality.

Condition of Surface Waters

Except for the main stem of the Colorado River, the base flow of all streams and rivers in the Grand Canyon watershed, including the Little Colorado River, is derived from the discharge of groundwater at springs in the watershed. The Virgin River watershed near Littlefield, Arizona, also depends on discharge from springs, which, although it is unlikely, might receive a contribution of flow from R-aquifer groundwater in the North Parcel, as described in Section 3.4. Therefore, potential impacts to these receiving surface waters are indirectly related to potential impacts to the associated groundwater systems and springs. It is assumed for the purposes of this impact analysis that the impact to surface streams is equivalent to the impact on the springs supplying discharge. This assumption could lead to a conservative overestimation of impacts if a stream is fed by multiple springs that are not all impacted and because in-stream attenuation is ignored.

The quantity of surface water runoff might be affected by soil disturbance, soil compaction, loss of vegetation, and diversion or re-routing of surface water drainages at roads, exploration sites, and mine sites. Chemical quality of surface water runoff might be affected by incorporation of material eroded from mine sites into native stream sediments, as well as constituents that might be dissolved from this material. Lastly, there is the potential for increased sedimentation from increased erosion along roads and at exploration and mine sites. Major increased sedimentation in perennial and ephemeral streams could adversely affect channel morphology, stream function, and associated riparian habitats. Because potential impacts to surface water runoff and stream function are dependent on impacts to soil resources, the analysis includes an evaluation of results of Sections 3.5 and 4.5 of this EIS. Impacts to ephemeral surface water drainages were assessed generically, rather than site specifically.

Cumulative Impacts

Assumed past, present, and future activities or conditions that might contribute to cumulative impacts on groundwater and surface water dependent on groundwater include the following:

- Other drilling (for oil, gas, and/or water), fluid mineral leasing programs, and mining activities (copper mines, small-scale stone quarries, or sand and gravel operations);

- Withdrawal of groundwater for use in wildlife water projects;
- Past uranium exploration projects, as summarized in the RFD scenarios in Appendix B;
- Past uranium mining activities at the closed Hack Canyon, Hack 1, Hack 2, Hack 3, Hermit, and Pigeon mines in the North Parcel, and the Orphan Mine near the South Parcel; and
- The Jackson Flat Water Supply Storage Project.

Assumed past, present, and future activities and conditions that could contribute to cumulative impacts on surface waters that receive runoff include the following:

- Fuels management and noxious weed removal programs;
- Wildlife management;
- Past wildfires and fire suppression; past livestock grazing; and past drought conditions;
- Recreation and tourism, including use, development, and maintenance of campgrounds and trails;
- Installation of roads and utilities (water and power lines);
- Development on private land, including development in response to population growth;
- Other drilling (for oil, gas, and/or water) and other mining activities (previous copper mines, small-scale stone quarries, or sand and gravel operations) and past uranium exploration projects, as summarized in the RFD scenarios;
- Past uranium mining activities at the closed Hack Canyon, Hack 1, Hack 2, Hack 3, Hermit, and Pigeon mines in the North Parcel and at the Orphan Mine near the South Parcel; and
- The Jackson Flat Water Supply Storage Project.

Impacts from these activities were combined with direct and indirect impacts from the activities described in the RFD scenarios; total impacts were evaluated to determine whether the impact category listed in Table 4.4-3 might change as a result of inclusion of impacts from additional activities. If addition of the activities outlined in the RFD scenarios was not likely to be the cause of an increase in impact magnitude, the magnitude assignment was not changed.

The spatial scale of cumulative impact analysis for stream function is different from that considered for direct and indirect impacts in that the impacts may not necessarily be related solely to the locations of uranium mining activities. In fact, the overall disturbance and increased erosion impacts resulting from RFD-scenario activities would be very small, compared with such impacts from other activities. Impacts from all past and present activities or conditions and from non-uranium mining activities or conditions that are reasonably foreseeable are difficult to quantify for stream function. Therefore, descriptions established in Table 4.4-1 are not used for discussion of cumulative impacts to stream function. Instead, cumulative impacts are analyzed through comparison of the relative magnitude, in qualitative terms, of impacts resulting from reasonably foreseeable uranium-mining activities and impacts resulting from other past, present, or reasonable foreseeable activities and conditions listed in Section 4.4.1.

4.4.2 Incomplete or Unavailable Information

Incomplete and unavailable information adds to uncertainty of analyses. This uncertainty cannot be readily quantified; however, where possible and appropriate, uncertainties have been addressed by the use of best available information and conservative assumptions when projecting potential impacts. For example, incomplete or unavailable data for monitoring for perched aquifers were addressed by assuming that any uranium mine within a conservatively estimated groundwater drainage area for a perched aquifer spring could cause a major impact to the spring. Therefore, reasonable assessments were made to provide the decision-maker with an adequate basis for weighing the relative potential for impacts to water resources from each alternative. It should be emphasized that detailed, site-specific environmental analysis could be required for any new mines in the proposed withdrawal area and that the data necessary to assess the potential impacts on a case by case basis would be obtained and evaluated at that time. In addition, the ADEQ may require new Aquifer Protection Program (APP) permits for existing mines operating under interim management plans; these permits can include measures for monitoring and environmental mitigation (for example, see ADEQ 2009d).

The data compiled for springs, streams, and wells chiefly comprise locations that have single results for measurement of spring discharge or stream flow, groundwater level measurements, or water sample analyses. Therefore, the temporal variation in these parameters has only been documented at several selected, but important, locations.

Because of the relative remoteness of areas north of the Colorado River, few quantitative data are available for springs and wells. Many perched aquifer springs and shallow wells have no data other than location, thereby limiting documentation of both spatial and temporal variation. Although remote, the parcels have historically received substantial visitation by various entities (administering agencies, American Indians, researchers, public and private interests, and recreationists), and it is unlikely that sources of water supply used and relied on in this arid region would be missing from the records. However, it is possible that undiscovered or unreported perched aquifer springs occur and are not considered in this assessment. Ephemeral perched aquifer springs may occur only after periods of precipitation and may not be documented. Records and assumptions for relative magnitude of discharge from perched aquifer springs in and near the North and East parcels were qualitatively corroborated by site visit reports by the BLM and NPS. The amount of vegetation visible on satellite and aerial imagery was also useful for the analysis.

Direction of groundwater movement in the regional aquifer of the North and East parcels has been estimated by previous investigations; however, these estimates were based on professional judgment and knowledge of the areas, supplemented with the few measured groundwater levels in the area. Further analyses using groundwater flow models are available for groundwater movement in the South Parcel; however, these models are based in part on sparse well data, are regional in scale, and are of limited use for assessment of site-specific groundwater flow conditions. Groundwater monitoring in the deep aquifer at mine sites was limited to data from a single well at each site.

Detailed documentation of specific reclamation results for the five reclaimed mines (Hack 1, 2, and 3; Hermit; and Pigeon) on the North Parcel was either incomplete or unavailable for this analysis. General information for reclamation and other aspects of the mines was available in documents submitted to the administering agencies, and helpful details were obtained from discussions with former mine personnel (personal communication, Pat Hillard, formerly with Energy Nuclear Fuels, Inc. 2010; personal communication, Roger Smith, formerly with Energy Nuclear Fuels, Inc. 2010; personal communication, John Stubblefield, Denison 2010) and personal communication with a breccia pipe expert (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010b, 2010c). This information was then used along with other available information to address the potential for mine drainage and associated impacts. No documentation was available for reclamation of the older (pre-1980) Hack Canyon Mine.

4.4.3 Compliance with Environmental Regulations and Permitting

For operations on BLM-managed lands, BLM's regulations require operators to implement appropriate design features and comply with all applicable state and federal laws to prevent unnecessary or undue degradation. For operations on Forest Service lands, regulations require that all operations, where feasible, shall be conducted to minimize all adverse environmental impacts on surface resources, including compliance with all federal and state water quality standards. It should be emphasized that detailed, site-specific environmental analysis could be required for any new mines in the proposed withdrawal area and that the data necessary to assess the potential impacts on a case by case basis would be obtained and evaluated at that time. Descriptions of measures employed to address water resource impacts were obtained from the final plan of operations for the EZ-1, EZ-2, and What mine (JBR Environmental Consultants 2010) and the APP recently issued by ADEQ for the Arizona 1 Mine (ADEQ 2009d). Active mine sites are routinely inspected for compliance with their approved plans of operation and other permits. Measures to limit and control soil resource impacts are discussed in Section 4.5; these measures are also generally applicable to protection of surface water resources and will not be repeated in this section. Examples of stipulations or required mitigation measures in approved plans of operations include the following:

- Nearby surface water features are identified to address any concerns regarding potential impacts that might occur to the features.
- Lined below-grade evaporation ponds are used to contain on-site runoff and mine drainage pumped from the collection sump at the bottom of the mine. These ponds are regulated by ADEQ’s APP, which generally requires BADCT to minimize leakage potential by way of a double liner and automated leak detection systems. APP permits include requirements to maintain proper fluid levels in the pond at all times and a contingency to ensure that this occurs. The evaporation pond is sized to retain stormwater runoff from a 100-year, 24-hour flood event. Off-site discharges of mine drainage or stormwater are not permitted under the APP program.
- Perimeter berms and diversion channels are engineered and constructed to withstand a 500-year, 24-hour flood event outside the mine site perimeter. These structures are required pursuant to plans of operation and APP permits. The perimeter berm is intended to contain mining-generated materials and soil within the site by preventing run-on from entering the site and run-off from leaving the site. Engineering designs for these berms are based on site-specific hydrologic models. Although failure or overtopping of the berms is not reasonably foreseeable, ADEQ would require remedial action under the APP permit in the unlikely event that waste rock, ore, and/or material from the evaporation pond were released from the site.
- Engineered ore pads are constructed to contain stockpiled waste rock and ore and prevent leaching of excavated material to native surface soil during rainfall events. Waste rock/ore stockpiles are regulated by ADEQ APP requirements, which include BADCT.
- Control of mine drainage is accomplished through the following APP permit requirements: total mine shaft depth is limited; the mine shaft(s) and sump(s) are required to be continuously dewatered; and the bottom of the sumps must pass permeability requirements and not have visible fractures or other secondary porosity features or must be sealed with bentonite.
- Monitoring requirements pursuant to the APP permit are as follows: the main mine shaft sump must be monitored monthly for the first year and annually thereafter; and the evaporation pond leak detection system monitoring data must be reported on a quarterly basis.
- The APP establishes the point of compliance as a contingency measure to be installed in the event of a known release of pollutants to groundwater, which typically consists of monitor wells located

downgradient of the site. If groundwater inflow to the mine does not decrease over the first 3 years of operation, a monitor well must be installed into the R-aquifer.

- Reclamation efforts include an extensive radiometric survey of the areas of operation. Any material encountered that exceeds the acceptable radiation standard for long-term exposure (10 mrem/yr) is removed from the site or buried in the mine workings before the area is graded and covered with soil. At closure, soils are required to meet ADEQ SRLs.
- Each mine operator is required to submit an interim management plan for approval with the site plan of operations. These plans establish actions required during periods of temporary or seasonal closure to avoid causing unnecessary or undue degradation. Such actions include measures to: stabilize excavations and workings; isolate or control toxic or deleterious materials; store or remove project equipment, supplies, and structures; and maintain the site in a safe, clean condition. In addition, the plan must address monitoring that will be conducted during the period of non-operation; the amount and type of monitoring is determined based on several factors, such as the type of operation and risk of environmental impacts. The regulations also require the operator to maintain an adequate financial guarantee and include provisions for agency review of the interim management status of a project that has been inactive for 5 years to determine whether the project should terminate its plan of operations and begin final closure and reclamation.

4.4.4 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

Potential direct impacts to water resources include 1) impacts to local perched aquifers that support nearby perched aquifer springs and/or wells in or adjacent to each parcel; 2) impacts to the R-aquifer in and adjacent to each parcel and to R-aquifer springs and wells in or adjacent to each parcel; and 3) impacts to surface water resources and surface water drainage channels in or adjacent to each parcel. Potential indirect impacts to groundwater resources include impacts to R-aquifer springs and wells located outside and at a distance from each parcel. Potential indirect impacts to surface water resources and surface water drainage channels are those that are located outside and at a distance from each parcel.

GROUNDWATER

For this analysis, groundwater resources include perched aquifer springs and wells, as well as R-aquifer springs and wells. Resource condition indicators for groundwater resources are listed at the beginning of Section 4.4.1. Total number of existing and anticipated mines for Alternative A is 21 mines for the North Parcel, two mines for the East Parcel, and seven mines for the South Parcel (see Table B-15, Appendix B). Projected total water use for these mines is 221 mgal (average of 21 gpm for 20 years) for the North Parcel, 21 mgal (average of 2 gpm for 20 years) for the East Parcel, and 74 mgal (average of 7 gpm for 20 years) for the South Parcel (see Table B-15, Appendix B). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Potential impacts for the four EIS alternatives, assigned by resource condition indicator, parcel, and type of impact (direct and indirect, or cumulative), are summarized in Table 4.4-3.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the protective buffer area calculations for perched aquifer springs described in Section 4.4.1 and shown in Figure 4.4-1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are likely located within the groundwater drainage area for a perched aquifer spring.

It is not known where the other 18 anticipated mines estimated in the RFD scenarios may be located. As described in Section 4.4.1, change in the quantity or chemical quality of the discharge from perched aquifer springs cannot be projected with the data available. Therefore, it is assumed that any mine located within the groundwater drainage area calculated for a spring might cause an impact ranging from none to major to that spring. However, the probability that a spring might be impacted by implementation of an alternative was evaluated for each parcel using the methods and assumptions described in Section 4.4.1. Results of this evaluation are summarized in Table 4.4-4. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 13.3%, which is classified as a moderate impact according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

East Parcel Springs: The sole potential mine identified for the East Parcel is House Rock. It is not known where either of the two anticipated mines estimated in the RFD scenarios may be located. There are seven perched aquifer springs mapped in the East Parcel (see Figure 4.4-2). Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the East Parcel is 1.3%, which is classified as a negligible impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the protective buffer area calculated for a perched aquifer spring (see Figure 4.4-3). It is not known where the other six anticipated mines estimated in the RFD scenario may be located. There is one perched aquifer spring mapped in the South Parcel (see Figure 4.4-3). Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the South Parcel is 0.2%, which is classified as a negligible impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

Wells: Whereas the locations and characteristics of springs are defined by natural processes, the location, depth, and characteristics of water wells in the proposed withdrawal area are defined by both natural processes and human-directed processes, such as need, physical access, and regulations. Perched aquifer wells might cause mutual water level impacts on each other and on discharge from perched aquifer springs. Water quantity and water quality impacts to wells may be caused by numerous factors related to local variations in the aquifers and the design and operation of the wells. Perched aquifer wells are an important source of water for ranching operations and small industrial uses, and pumped water may also be used by wildlife. Because the perched groundwater zones are small and discontinuous, it is not possible to know their location and extent where they do not support the discharge from a spring or well. Wells can potentially be located anywhere and to any depth in the future, and data for pumping rate, aquifer hydraulic properties, and chemical quality of most wells are not available in the proposed withdrawal area. Therefore, it is not possible to reasonably calculate or locate protective buffer areas or groundwater drainage areas or perched aquifer wells. It is assumed that breccia pipe uranium mines, if located near perched aquifer wells, might impact both the quantity and chemical quality of discharge from the perched aquifer wells. However, it is also possible that these impacts might not occur.

As described in Section 4.4.1, deep mineral exploration boreholes and R-aquifer water supply wells for the mines might provide potential conduits for movement of perched aquifer groundwater and mineralized groundwater drainage to the R-aquifer. AAC Title 12, Chapter 15, Article 8 requires proper construction and abandonment of wells to prevent cross-contamination of different aquifers. For the purposes of this EIS, it must be assumed that state and federal regulations have been and are being met. Therefore, because the regulations are protective of groundwater, deep drilling operations that occurred after the regulations were adopted on March 5, 1984 (ADWR 2008), are considered to represent no impact or a negligible impact to the quantity and quality of perched groundwater available to perched aquifer springs or wells. Duration of the negligible impact would likely range from temporary to short term (see Table 4.4-2). Based on the factors described in Section 4.4.1, pre-1984, pre-regulation wells

Table 4.4-3. Summary of Potential Water Resources Impacts

Resource Condition Indicator	Alternative A North Parcel	Alternative A East Parcel	Alternative A South Parcel	Alternative B North Parcel	Alternative B East Parcel	Alternative B South Parcel	Alternative C North Parcel	Alternative C East Parcel	Alternative C South Parcel	Alternative D North Parcel	Alternative D East Parcel	Alternative D South Parcel
Perched Aquifer Springs												
Water Quantity and Quality	Moderate	Negligible	Negligible	Moderate	None	None	Moderate	None	None	Moderate	None	Negligible
Perched Aquifer Wells												
Water Quantity and Quality	None to Major	None to Negligible	None to Negligible	None to Negligible	None	None to Negligible	None to Moderate	None to Negligible	None to Negligible	None to Moderate	None to Negligible	None to Negligible
R-aquifer Springs												
Water Quantity	Negligible	Negligible	Negligible for Havasu and Blue Springs; None to Major for South Rim springs	Negligible	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Quality	None to Moderate	None to Moderate	None to Negligible for Havasu and Blue Springs; None to Major for South Rim springs	None to Moderate	None	None to Negligible	None to Moderate	None to Moderate	None to Negligible	None to Moderate	None to Moderate	None to Negligible
R-aquifer Wells												
Water Quantity	None	None	Negligible	None	None	Negligible	None	None	Negligible	None	None	Negligible
Water Quality	None	None	None to Major	None	None	None to Major	None	None	None to Major	None	None	None to Major
Surface Waters												
Water Quantity	Negligible to Moderate	Negligible to Moderate	Negligible to Major	Negligible to Moderate	None	Negligible	Negligible to Moderate	Negligible	Negligible	Negligible to Moderate	Negligible	Negligible to Moderate
Water Quality	Negligible to Moderate	Negligible to Moderate	Negligible to Major	Negligible to Moderate	None	Negligible	Negligible to Moderate	Negligible	Negligible	Negligible to Moderate	Negligible	Negligible to Moderate
Stream Function	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	None	Negligible	Negligible to Moderate	Negligible	Negligible	Negligible to Moderate	Negligible	Negligible to Moderate

Note: See Table 4.4-1 for definitions of impacts.

Table 4.4-4. Probability of Impact to Perched Aquifer Springs Quantity or Quality

Parcel	Total New Mines in Parcel[a]	Total New Mines in Non-withdrawal Area[b]	Total Perched Springs for Parcel[c]	Total of Spring Drainage Areas in Parcel[d] (square miles)	Total of Spring Drainage Areas in Non-withdrawal Area[e] (square miles)	Total Withdrawal Area of Parcel (square miles)	Total Non-withdrawal Area of Parcel (square miles)	Estimated Probability of Impact[f] (%)
Alternative A								
North	18	18	29	6.8	6.8	0	859.4	13.3
East	2	2	7	1.4	1.4	0	210.1	1.3
South	6	6	1	0.2	0.2	0	503.3	0.2
Alternative B								
North	7	0	29	6.8	0	859.4	0	5.4
East	0	0	7	1.4	0	210.1	0	0
South	0	0	1	0.2	0	503.3	0	0
Alternative C								
North	10	3	29	6.8	1.4	549.9	309.4	6.7
East	1	1	7	1.4	0	141.0	69.1	0
South	3	3	1	0.2	0	322.8	180.5	0
Alternative D								
North	17	10	29	6.8	4.1	160.3	699.1	10.8
East	1	1	7	1.4	0	87.9	122.2	0
South	4	4	1	0.2	0.2	208.2	295.0	0.3

[a] Total number of new mines anticipated for the entire parcel for each alternative, including areas proposed for withdrawal and not proposed for withdrawal.

[b] Total number of new mines anticipated outside the proposed withdrawal area for the indicated parcel. This number is the same as the total number of new mines anticipated for the entire parcel, except for Alternatives B, C, and D in the North Parcel, where seven of the new mines could be located anywhere on the parcel, regardless of the proposed withdrawal area (see Appendix B).

[c] Total number of groundwater drainage areas for perched aquifer springs that are within or overlap the parcel boundary; see Figures 4.4-1 through 4.4-3 for location of springs.

[d] Sum of the groundwater drainage areas (estimated using the method described in Section 4.4.1) for perched aquifer springs whose groundwater drainage areas are within or overlap the parcel boundary. If any part of the groundwater drainage area for a spring overlaps the parcel boundary, the entire groundwater drainage area estimated for that spring was included in this sum and in the calculation of impact probability.

[e] Sum of the groundwater drainage areas (estimated using the method described in Section 4.4.1) for perched aquifer springs whose groundwater drainage areas are within or overlap the non-withdrawal area of the parcel. If any part of the groundwater drainage area for a spring overlaps the non-withdrawal area of a parcel, the entire groundwater drainage area estimated for that spring was included in this sum and in the calculation of impact probability.

[f] Probability (calculated using the method described in Section 4.4.1) that a new breccia pipe uranium mine would be located within the groundwater drainage area of a perched aquifer spring located in or adjacent to the parcel.

represent a negligible impact to the quantity and quality of perched groundwater available to perched aquifer springs or wells. Duration of this negligible impact would likely range from temporary to long term (defined in Table 4.4-2).

The following salient conclusions can be made regarding perched aquifer wells in the parcels:

- The primary risk to existing and future perched aquifer wells from breccia pipe uranium mines on the parcels is the depletion of the small, thin, and discontinuous perched aquifer zones by groundwater drainage into mine openings.
- Because of the localized nature of perched aquifers, only perched aquifer wells that are relatively near a mine might be expected to be impacted. The perched aquifers at mineralized breccia pipes commonly contain poor quality groundwater due most commonly to the sulfide mineralization in the breccia pipes at the level of the perched groundwater above the Hermit Formation and therefore are not preferred targets for perched aquifer water supplies.

- As described in Section 4.4.1, available well records (see Appendix D) indicate that, during the past 20 years, only five non-mineral-exploration wells have been completed in perched aquifers in the North Parcel, and none have been drilled in the East and South parcels; many of the recorded wells are likely either unused or abandoned. These wells are commonly installed to supply grazing or surface mining operations; grazing activity has declined on the parcels over the past 20 years, and anticipated growth in surface mining operations is expected to be very limited. These factors, together with the permitting necessary to drill on federal lands, indicates that the number of new perched aquifer wells on the parcels will likely be none or few during the next 20 years.
- If mine reclamation or preventive measures taken during mine operations successfully re-establish the perching layer penetrated by the mine openings, the perched groundwater zone would be expected to be replenished by local recharge over time. The amount of time required for the recovery to pre-mining conditions is dependent on many factors and is uncertain, but might be on the order of several years or more. If no such reclamation or preventive measures are taken, then depletion of the perched aquifer would be expected to continue, and groundwater drainage from the aquifer would decrease until it reached equilibrium with the meager natural recharge to the local perched aquifer. Groundwater yield to impacted perched aquifer wells would diminish accordingly.

For the purposes of this EIS, potential impact to the quantity and quality of discharge from perched aquifer wells was assumed to be directly related to the anticipated number of mines for each parcel under each alternative. It was assumed that zero to half of the anticipated number of mines might be located within the perched groundwater zone that supports a well for the 20-year period of this analysis. Based on this assessment, it was assumed that this number of mines is zero to 11 for the North Parcel, zero to one for the East Parcel, and zero to four for the South Parcel. These assumptions are classified as no impact to major impact for the North Parcel and no impact to negligible impact for the East and South parcels, according to the criteria given in Table 4.4-1. Duration of these impacts would likely range from short term to long term (defined in Table 4.4-2).

R-aquifer Springs Quantity

North Parcel: Potential impact to quantity and quality of discharge from R-aquifer springs is considered both a direct and indirect impact in the North Parcel because the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) are located about 2 linear miles south of the North Parcel boundary but more than 20 miles from the more distant parts of the North Parcel groundwater system that likely flows southward. Travel time for groundwater is directly related to length of flow path. Therefore, travel time for R-aquifer groundwater from the North Parcel could range widely. The combined average groundwater demand over 20 years for all 21 mines predicted for the North Parcel is 21 gpm (see Appendix B), which is about 4.5% of the aggregate discharge of 470 gpm from Kanab and Showerbath springs (see Appendices E and G). This aggregate discharge rate is based on a single measurement at each of these locations; therefore, average discharge is uncertain. In addition, although Kanab and Showerbath springs are distinct point locations for groundwater discharge (start of perennial flow and large volume input source, respectively), the reach between them is a gaining reach, where groundwater discharge located within the channel is composed of diffuse, rather than point, sources (personal communication, S. Rice, Grand Canyon National Park 2010). The locations and discharge from the diffuse sources along the creek are unknown. In addition, it is difficult to measure all the discharge from such diffuse systems. Therefore, the actual aggregate discharge from the R-aquifer in this reach of Kanab Creek is likely larger than the reported measurements for Kanab and Showerbath springs. Impacts, if any, from pumping of distant mine wells would likely be distributed over the diffuse spring discharge area and would be less than impacts projected using only the discharge from Kanab and Showerbath springs.

Because of groundwater divides that occur in the North Parcel, it is not likely that all of these mine wells would be located in the groundwater basin of Kanab and Showerbath springs. However, even if it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from these springs, the decrease would likely be less than the error of measurement for commonly used stream gaging methods (Harmel et al. 2006). Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

As described in Sections 3.4 and 4.4.1, it is unlikely that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona. However, if such a connection does occur, the contribution of flow to large spring complexes (flow about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex [personal communication, Don Bills, USGS 2010b]) along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small. If no spring flow is contributed from the North Parcel, there would be no impact. If flow is contributed, a very conservative assessment of potential impact can be made using the following assumptions. Considering the lowest of the reported aggregate spring flow rates (9,000 gpm) and even assuming that all 21 mines anticipated under Alternative A for the North Parcel would be located within the Virgin River groundwater basin (total mine pumping of 21 gpm over the 20-year period of this analysis), the maximum calculated decrease in discharge would be less than 0.5%, which is negligible and not measurable. Duration of this impact would likely be long term (defined in Table 4.4-2).

East Parcel: Similar to the North Parcel, potential impact to quantity and quality of discharge from R-aquifer springs is considered both a direct and indirect impact in the East Parcel because the nearest reported R-aquifer springs, the Fence Fault spring complex, are located within 1 mile of the parcel boundary but more than 15 miles from the more distant parts of the East Parcel, resulting in a wide range of groundwater travel times. The combined average groundwater demand over 20 years for the two mines predicted for the East Parcel is 2 gpm (see Appendix B). Groundwater discharge from the R-aquifer at the Fence Fault complex occurs at several springs on both sides of the Colorado River and in the river channel where it occurs in the R-aquifer. The average aggregate estimated discharge for only the springs on the west side of the river near South Canyon is about 3,700 gpm (see Appendices E and G). If R-aquifer discharge in the Colorado River channel could be measured, this aggregate value would likely be much larger. If it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from these springs, the decrease would be less than 0.1% of the estimated aggregate discharge (using 3,700 gpm) and would be considered a negligible impact and not measurable (see Table 4.4-1). Duration of this impact would likely be long term (defined in Table 4.4-2).

South Parcel: The South Parcel is adjacent to Grand Canyon National Park on the north and is separated from the South Rim of Grand Canyon by a strip of NPS land ranging in width from less than 1 mile to about 5 miles. More than 15 small to moderate-sized springs issue from the R-aquifer along the south wall of Grand Canyon north of the South Parcel and support important local ecosystems. There is disagreement among researchers about whether or not many of these springs are too poorly connected hydraulically to the R-aquifer to be significantly impacted by R-aquifer wells located several miles from the South Rim. For the purposes of this EIS, it is assumed that these springs may or may not be sufficiently connected hydraulically to the regional aquifer to be impacted if the wells are located along or north of the near-rim groundwater divide estimated for the R-aquifer by Bills et al. (2007) (see Figure 4.4-3).

The sole existing mine well (Canyon) is more than 5 miles south of this groundwater divide, in the groundwater basin that drains to the distant Havasu Springs. It is not known where the other six anticipated mines estimated in the RFD scenarios might be located; however, based on the location of other identified breccia pipes, it could be assumed that one of the mines might be located north of the groundwater divide, in the near-rim groundwater basin that drains to R-aquifer springs along the South Rim of Grand Canyon. The remaining mines could be assumed to be located several miles south of the groundwater divide in the Havasu Springs groundwater basin and/or north of the groundwater divide in the groundwater basin that drains to the large Blue Springs system along the Little Colorado River. Because of the distance from the South Parcel, potential impacts assumed for Havasu Springs and Blue Springs are considered to be indirect. The potential impacts assumed for springs along the South Rim of Grand Canyon are considered to be direct as a result of proximity.

The combined average groundwater demand over 20 years for the seven mines predicted for the South Parcel is 7 gpm (see Appendix B). Average discharge from Havasu Springs is about 29,000 gpm. Even if it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from Havasu Springs, the decrease would be less than 0.1% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

Based on the estimates given in Appendix B (see Section B.8.1.14), combined groundwater demand for six of the anticipated mines is calculated to be about 194 acre-feet over 20 years, or an average of 6 gpm. Average discharge from the nearest part of the Blue Springs complex is assumed to be about 46,000 gpm (see Figure 4.4-3). Even if it is assumed that all of the projected groundwater pumping for these six mines under this alternative would cause a direct decrease in discharge from the nearest part of the Blue Springs complex, the decrease would be less than 0.1% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

Based on the estimates given in Appendix B (see Section B.8.1.14), average groundwater demand for a single mine would be 5 gpm over a 4-year period. To provide an assessment for potential impacts to springs along the south wall of the Grand Canyon, it was assumed that an R-aquifer spring having an average discharge of 5 gpm might or might not be impacted by one of the anticipated mines if located in the northern part of the parcel. Under this assumption, the decrease in discharge at this spring might range from 0% to 100% and would be considered either no impact or a major impact, respectively (see Table 4.4-1). Duration of this impact would likely be long term (defined in Table 4.4-2). If the mine were located in the groundwater basin for either the Hermit Springs complex or the Garden Springs complex (aggregate discharge for each is about 300 gpm) and would impact these springs, the decrease in aggregate discharge at one of these spring complexes would be less than 2% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

It should be noted that each of the groundwater drainage areas that support the Hermit Springs and Garden Springs complexes likely extends southwestward along the associated southwest-trending fault zones that intersect the Grand Canyon at these locations. These groundwater drainage areas may extend further southwest than indicated by the R-aquifer groundwater divide estimated by Bills et al. (2007) and shown in Figure 4.4-3.

R-aquifer Wells Quantity

As described for perched aquifer wells, R-aquifer wells may cause water level impacts on each other (mutual impacts) and on discharge from R-aquifer springs. Water quantity and water quality impacts to wells may be caused by numerous factors related to the local variations in the aquifers and the design and operation of the wells. The only existing non-mine R-aquifer wells within the parcels are three wells located at Tusayan on the South Parcel (see Table 3.4-1, Figure 3.4-13). These wells provide an important source of public drinking water to the community of Tusayan. The next nearest non-mine R-aquifer wells are two wells that provide public drinking water supply at the community of Valle, located about 10 miles south from the South Parcel. The following salient conclusions and assumptions can be made regarding R-aquifer wells in the parcel areas:

- The impact to the R-aquifer from water level drawdown related to groundwater withdrawals from mine supply wells is expected to be very small because the amount of groundwater projected to be withdrawn for mine use is very small (about 5 gpm for 4 years on average; see Appendix B). The only existing non-mine R-aquifer wells in the proposed withdrawal area are located at Tusayan on the South Parcel. Therefore, Alternative A for the South Parcel appears to carry a potential for water level drawdown impact at existing non-mine R-aquifer wells as a result of pumping at mine wells.
- The regional R-aquifer is deep, and costs for drilling, construction, and pump equipment are very high; total cost can exceed $3 million for one well. Records indicate that no non-commercial, non-industrial, non-municipal, or non-agency entities have installed R-aquifer wells on the parcels, even though the R-aquifer is recognized as the only reliable undeveloped source of groundwater in this water-short area. Although groundwater yield from the R-aquifer is prolific where fractures are abundant, interconnected, and solution-enhanced, there is significant risk that wells may not encounter these fracture zones and may be dry. Therefore, financial risk is significant for R-aquifer well construction. Based on these factors and projected demand, no new non-mine R-aquifer wells are anticipated to be drilled on or near the North and East parcels for the 20-year period of this analysis. It is assumed that demand for water supply in the Fredonia area north of the North Parcel could be met by wells in the shallower, more easily accessed groundwater system there. However, it is possible that the small population centers at Tusayan and Valle might drill additional R-aquifer production wells to meet potential increases in demand for public water supply.

As described in Section 4.4.1, results of analysis suggest that the off-mine-site drawdown caused by mine wells would be determined to be acceptable using the criterion used by ADWR for well impact in AMAs. Based on the location of existing wells and the projected construction of new wells, it is not likely that mines would be located sufficiently near a non-mine R-aquifer water supply well to cause more than a negligible water level drawdown impact to the non-mine well, according to the criteria given in Table 4.4-1. Because it is anticipated that no more than six mines would be in operation at any one time (see Appendix B, Section B.8.1.7), the potential total drawdown impact to existing wells at Tusayan, Valle, or more distant areas from pumping mine wells would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of the impact would likely range from short term to long term (defined in Table 4.4-2).

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative A analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: The following assumptions were made for this assessment:

1. Zero to half of the 21 mines (11 mines) predicted for the North Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs).

2. The average ambient concentration of dissolved uranium in the aggregate discharge (470 gpm) from these springs is 4.9 µg/L, and the concentration of dissolved arsenic is about 2 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium at the springs ranges from 4.9 to 14 µg/L and the projected concentration of dissolved arsenic ranges from 2 to 4 µg/L (see Table 4.4-5). The smaller value of each range equals the ambient concentration. None of these concentrations exceed the EPA MCLs for drinking water (30 µg/L for uranium; 10 µg/L for arsenic) for humans, but the larger values of each range do represent increases from ambient concentrations. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife.

Table 4.4-5. Summary of Projected Impact on R-aquifer Spring Water Quality

Parcel	Number of Mines Contributing Impacted Water[a]	Spring	Spring FlowRate[b] (gpm)	Constituent	Ambient Concentration Range[c] (µg/L)	Ambient Concentration[d] (µg/L)	Projected Concentration[e] (µg/L)
Alternative A							
North	0–11	Kanab / Showerbath	470	Uranium	4.7–5.2	4.9	4.9–14
				Arsenic	1–2	2	2–4
East	0–1	Fence Fault complex	3,700	Uranium	0.6–2.3	1.7	1.7–1.8
				Arsenic	1–20	10[f]	10[f]
South	0–4	Havasu Springs	29,000	Uranium	4–10	6	6
				Arsenic	5–20	10[f]	10[f]
	0–4	Blue Springs	46,000	Uranium	1–30	7	7
				Arsenic	4–5	5	5
	0–1	Hermit complex	300	Uranium	2–5	3	3–4
				Arsenic	10	10[f]	10[f]
	0–1	Indian Garden complex	300	Uranium	2–20	3	3–5
				Arsenic	1–5	4	4
	0–1	Small South Rim spring	5	Uranium	1–8	4	4–70[f]
				Arsenic	1–20	10[f]	10[f]–30[f]
Alternative B							
North	0–5	Kanab / Showerbath	470	Uranium	4.7–5.2	4.9	4.9–9.0
				Arsenic	1–2	2	2–3
South	0–1	Havasu Springs	29,000	Uranium	4–10	6	6
				Arsenic	5–20	10[f]	10[f]
Alternative C							
North	0–7	Kanab / Showerbath	470	Uranium	4.7–5.2	4.9	4.9–11
				Arsenic	1–2	2	2–3
East	0–1	Fence Fault complex	3,700	Uranium	0.6–2.3	1.7	1.7–1.8
				Arsenic	1–20	10[f]	10[f]
South	0–2	Havasu Springs	29,000	Uranium	4–10	6	6
				Arsenic	5–20	10[f]	10[f]

Table 4.4-5. Summary of Projected Impact on R-aquifer Spring Water Quality (Continued)

Parcel	Number of Mines Contributing Impacted Water[a]	Spring	Spring FlowRate[b] (gpm)	Constituent	Ambient Concentration Range[c] (µg/L)	Ambient Concentration[d] (µg/L)	Projected Concentration[e] (µg/L)
Alternative D							
North	0–10	Kanab / Showerbath	470	Uranium	4.7–5.2	4.9	4.9–13
				Arsenic	1–2	2	2–3
East	0–1	Fence Fault complex	3,700	Uranium	0.6–2.3	1.7	1.7–1.8
				Arsenic	1–20	10[f]	10[f]
South	0–3	Havasu Springs	29,000	Uranium	4–10	6	6
				Arsenic	5–20	10[f]	10[f]

[a] Assumed number of mines that might contribute impacted water to the R-aquifer.

[b] Flow rate estimated as follows: Kanab / Showerbath is sum of both springs from Bills et al. (2010); Fence Fault complex represents sum of average spring flow listed in Appendix E for R-Aquifer springs along west bank of Colorado River in the vicinity of the Fence Fault (including Vasey's Paradise); Havasu and Blue springs are average flow rates from Appendix E; Hermit and Indian Garden complexes estimated from Montgomery (1999); Small South Rim spring is an average of spring flow data for South Rim R-aquifer springs from Appendix D, excluding Hermit, Indian Garden, and Pipe Springs.

[c] Absolute minimum and maximum reported concentration for each spring or spring complex rounded to the number of significant digits appropriate for the calculation of projected concentrations. Data are from Appendix G.

[d] Ambient concentrations are the average of values for each spring or complex listed in Appendix G, rounded to the number of significant digits appropriate for the calculation of projected concentrations.

[e] Projected concentrations based on mass flux calculations assuming mine drainage to the R-aquifer occurs at a long-term average rate of 1 gpm, with a concentration of 400 µg/L for uranium and 90 µg/L for arsenic. It is assumed that the only attenuation of the mine drainage is dilution with the total volume of water discharging at each spring (see Section 4.4.1 for explanation of the method).

[f] Concentration equals or exceeds EPA MCL for drinking water (30 µg/L for uranium; 10 µg/L for arsenic).

As described previously, it is unlikely that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona, about 46 miles northwest from the boundary of the North Parcel. However, if such a connection does occur, the contribution of flow to large spring complexes (flow about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex [personal communication, Don Bills, USGS 2010b]) along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small. Further, the portion of any contribution of flow from the North Parcel that is attributable to potential drainage from breccia pipe uranium mines would be zero or exceedingly small (11 gpm total assumed for the preceding analysis). Additional factors that would likely diminish metal concentrations in any mine drainage include the large distance from the North Parcel and the long residence time of the solution in the aquifer, the geochemical characteristics of the groundwater system, which tend to remove metals from groundwater, and the ample opportunities for further dilution along the long and complex flow path that the groundwater would need to traverse to reach the Virgin River. Therefore, even if there is a contribution to the Virgin River from the R-aquifer beneath the North Parcel, the potential impact on water quality attributable to drainage from North Parcel breccia pipe uranium mines would be negligible and not measurable. Duration of any such impact would be long term (defined in Table 4.4-2).

East Parcel: The following assumptions were made for this assessment:

1. Zero to one of the two mines predicted for the East Parcel is assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic to the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (west side Fence Fault complex in Marble Canyon).
2. The average ambient concentration of dissolved uranium in the aggregate discharge (3,700 gpm) from these springs is 1.7 µg/L, and the concentration of dissolved arsenic is about 10 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium at the springs ranges from 1.7 to1.8 µg/L, and the projected concentration of dissolved arsenic is 10 µg/L (see Table 4.4-5). The smaller uranium value and the arsenic value equal the ambient concentrations. The uranium concentrations do not exceed the EPA MCL for drinking water (30 µg/L) for humans, but the larger value does represent an increase from the ambient concentration. The ambient arsenic concentration is equal to the EPA MCL for drinking water (10 µg/L). These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife.

As described in Chapter 3, breccia pipe mines located adjacent to deep canyon walls, which cut the low-permeability breccia and rock units between the mine openings and the R-aquifer, are subject to increased risk of enhanced fracture development, which may decrease these rocks' ability to retard the downward movement of perched groundwater that might enter the mine openings. Therefore, there is an increased risk at such mines for mine drainage that might occur to reach and impact the R-aquifer. The only area on the parcels where such conditions might occur is along the west wall of Marble Canyon, which forms the eastern boundary of the East Parcel. It is unknown whether the House Rock breccia pipe is near enough to the canyon walls to be at increased risk of these conditions (see Figure 4.4-2).

South Parcel: The following assumptions were made for this assessment:

1. Zero to half (four) of the seven mines predicted for the South Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest downgradient R-aquifer springs undiminished. Zero to four of the mines contributing impacted water are assumed to be located within the Havasu or Blue springs groundwater basins, and zero to one of the mines is assumed to be located within the near-rim area that supports springs along the South Rim of Grand Canyon. The discharge from these springs used in the calculations is 29,000 gpm for the Havasu Springs complex, 46,000 gpm for the nearest part of the Blue Springs complex, 5 gpm for a typical small R-aquifer spring along the South Rim, and 300 gpm spring each for Hermit and Garden springs (see Table 4.4-5).
2. The average ambient concentration of dissolved uranium is about 6 µg/L in the discharge from Havasu Springs, about 7 µg/L for Blue Springs, about 4 µg/L for a small R-aquifer spring along the South Rim, and about 3 µg/L for either Hermit or Garden springs (see Table 4.4-5).
3. The average ambient concentration of dissolved arsenic is about 10 µg/L in the discharge from Havasu Springs, about 5 µg/L for Blue Springs, about 10 µg/L for a small R-aquifer spring along the South Rim, about 10 µg/L for Hermit Springs, and about 4 µg/L for Garden Springs (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium is 6 µg/L for Havasu Springs and 7 µg/L for the nearest part of Blue Springs (see Table 4.4-5). The projected concentration of dissolved arsenic is 10 µg/L for Havasu Springs and 5 µg/L for the nearest part of Blue Springs. None of these concentrations exceed the ambient levels. The ambient arsenic concentration for Havasu Springs is equal to the EPA MCL for drinking water (10 µg/L) for humans. These results would represent a range from no impact to negligible impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

The resulting projected total concentration of dissolved uranium at a typical small R-aquifer spring along the South Rim ranges from 4 to 70 µg/L (see Table 4.4-5). The projected concentration of dissolved arsenic ranges from 10 to 30 µg/L. The larger value in the projected uranium range represents an increase from ambient levels and exceeds the EPA MCL for drinking water (30 µg/L). The ambient arsenic concentration is equal to the EPA MCL for drinking water (10 µg/L), and the larger value in the projected arsenic range represents an increase from ambient levels and exceeds the MCL. These results would represent a range from no impact to major impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

The resulting projected total concentration of dissolved uranium at the other South Rim springs ranges from 3 to 4 µg/L for Hermit Springs and ranges from 3 to 5 µg/L for Garden Springs (see Table 4.4-5). The projected concentration of dissolved arsenic is 10 µg/L for Hermit Springs and 4 µg/L for Garden Springs. The larger values in each projected uranium range represent an increase from ambient levels but do not exceed the EPA MCL for drinking water (30 µg/L). The ambient arsenic concentration for Hermit Springs is equal to the EPA MCL for drinking water (10 µg/L), but none of the projected arsenic concentrations exceed ambient levels. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife.

R-aquifer Wells Quality

North Parcel: Based on the description given in Section 4.4.1 of potential impacts to R-aquifer quantity and quality, together with the description given in the present discussion for R-aquifer quantity, no R-aquifer wells are projected to occur in the North Parcel for the 20-year period of this analysis. This result would be considered to represent no impact, according to the criteria given in Table 4.4-1.

East Parcel: Similar to the North Parcel, no R-aquifer wells are projected to occur in the East Parcel for the 20-year period of this analysis. This result would be considered to represent no impact, according to the criteria given in Table 4.4-1.

South Parcel: Based on the description given in Section 4.4.1 of potential impacts to R-aquifer quantity and quality, together with the description given in the present discussion for R-aquifer quantity, it is considered unlikely but possible that water quality at R-aquifer wells at Tusayan or Valle could be impacted by anticipated mining operations in the South Parcel for the 20-year period of this analysis. This result would be considered to represent a range from no impact to major impact, according to the criteria given in Table 4.4-1. Duration of the impact would likely be long term (defined in Table 4.4-2). Please refer to Section 4.4.1 (Subsections Chemical Quality of Regional R-Aquifer Springs and Wells – Wells) for a detailed explanation of the rationale for projected potential impacts to R-aquifer wells in the South Parcel.

SURFACE WATER

Surface waters that could potentially be impacted by mining-related activities in the proposed withdrawal area include perennial and ephemeral stream flow, the channels that convey the flow and associated riparian habitat, and surface water retention features, such as tanks, ponds, or playas. Potential impacts include the following:

- Impacts on water quantity resulting from reduced spring discharge; diversion or re-routing of surface water drainages for installation of roads and mine sites; or changes in runoff characteristics associated with disturbed soils.
- Impacts on water quality from spring discharge affected by mine drainage or from runoff impacted by waste materials eroded at mine sites and deposited in off-site stream channels and surface water impoundments.

- Impacts on stream morphology and function from increased sedimentation following ground disturbance or altered storm runoff related to disturbed areas.

These potential impacts would be considered direct impacts for nearby surface water drainages or retention structures, such as Kanab Creek for the North Parcel, and indirect impacts for more distant surface water drainages or retention structures, such as the Colorado River at its confluence with Kanab Creek. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Duration of all potential impacts to the Colorado River would likely range from short term to long term. Impacts to the Virgin River would be expected to be negligible for both water quantity and quality, as discussed in Subsection R-aquifer Springs Quantity and Subsection R-aquifer Springs Quality.

Water Quantity

The magnitude of impacts to the quantity of perennial surface water discharge for streams within the proposed withdrawal area depends on the estimated potential impact to the springs that supply base flow to individual streams. Most perennial streams in the region are supported by spring flow from the R-aquifer; short perennial reaches for some streams may be supported by perched aquifer springs. Tributaries in the study area contribute flow to the Colorado River; however, the river derives most of its flow upstream of the withdrawal area from Lake Powell.

- Quantity of flow impacts to perched springs that may support stream flow range from negligible in the East and South parcels to moderate in the North Parcel (see Perched Aquifer Springs and Wells Quantity and Quality in Table 4.4-3). Mines located in the drainage area of perched aquifer springs might result in the complete dewatering of the perched aquifer by mine openings, which would dry up the spring and any portion of surface flow dependent on the affected springs. Perched aquifer springs would be expected to show negligible impact where the probability of a mine being located within the groundwater drainage area of any perched aquifer spring would be less than 5% (East and South parcels; see Table 4.4-4). Moderate impacts are defined as a 5% to 20% probability of a mine being located within the drainage areas of any perched aquifer spring (North Parcel).
- Quantity of flow impacts to R-aquifer springs supporting streams are negligible for all three parcels, except for small South Rim springs adjacent to the South Parcel, which might be subject to impacts ranging from none to major (see Subsection R-aquifer Springs Quantity, above; see Table 4.4-3). Impact to Kanab Creek, which is the only perennial stream supported by R-aquifer springs in the North Parcel, would be expected to be negligible given the relatively large flow of the Kanab and Showerbath Springs. There are no perennial streams supported by R-aquifer springs adjacent to the East Parcel because these springs discharge very close to or in the Colorado River channel. For the South Parcel, quantity of flow impacts at Havasu and Blue springs, which support flow in Havasu Creek and the Little Colorado River, respectively, would be negligible given the large volume of flow discharging from these springs. For the small springs along the South Rim of the Grand Canyon adjacent to the South Parcel, no impacts would be expected to occur where mine supply wells are installed south of the R-aquifer groundwater divide; however, some larger springs might have larger drainage areas that cross the estimated location of the divide and thus might be impacted. Any impact to small South Rim springs might be major given the relatively small volume of flow at these springs.
- Quantity of flow impacts to the Colorado River in the study area from reduced spring flow would not be detectable (i.e., negligible impact) because of the large volume of water carried by the river, which averages a minimum of about 1.6 million gpm for USGS gaging stations from Glen Canyon Dam to Diamond Creek (USGS 2010d). The maximum possible reduction in flow from all potentially impacted R-aquifer springs is equal to the total foreseeable demand from 30 mine

wells, which is an average of 30 gpm for all three proposed withdrawal parcels over the 20-year period of this analysis. This flow rate is less than 0.002% of the average minimum Colorado River discharge and thus far less than the minimum probable uncertainty of 5% in typical stream flow measurements reported by Harmel et al. (2006).

Ephemeral stream flow might be impacted by altered runoff characteristics from disturbed areas during flooding, which might result in changes in peak flow rates and total flow volume. Changes in ephemeral stream flow are likely to be generally negligible (i.e., not detectable) because of the limited areas of surface disturbance anticipated in the RFD scenarios. However, where mines are located in or adjacent to areas of steep topography, changes in ephemeral stream flow might be detectable and might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites (as described in Section 4.5).

The volume of water available to surface water impoundments might be altered as a result of diversion of surface water drainage channels to accommodate mine sites and possibly roads in some areas prone to erosion. The effect might be either 1) to increase the volume if additional surface water drainage is directed to the structures or if more water is available as a result of increased runoff, or 2) to decrease the volume if surface water drainage supplying the impoundment is retained within the mine site perimeter, re-routed, or increased sedimentation reduces the impoundment capacity. Additionally, wells that may supply surface water impoundments for stock or wildlife use might be impacted along with the aquifer, as discussed in previous subsections. Overall, these impacts would be expected to be localized to areas near roads, exploration sites, and mine sites, given the design features in place to retain natural surface water drainage and to reduce and control erosion and runoff where possible. Because of the relative scarcity of surface water impoundments in the parcels, these impacts are also unlikely to be a concern except at some specific sites, and potential surface water drainage impacts would be addressed in site-specific analysis when a plan of operations is submitted.

Overall water quantity impacts to surface waters under Alternative A range from negligible to moderate for the North and East parcels and negligible to major for the South Parcel (see Table 4.4-3).

Water Quality

The magnitude of impacts to the quality of perennial surface water discharge depends on the estimated potential impact to the springs that supply base flow to individual streams. Most perennial streams in the region are supported by spring flow from the R-aquifer; short perennial reaches for some streams may be supported by perched aquifer springs. Tributaries in the study area contribute flow to the Colorado River; however, the river derives most of its flow upstream of the withdrawal area from Lake Powell.

- Water quality impacts to perched springs that may support stream flow range from negligible in the East and South parcels to moderate in the North Parcel (see Subsection R-aquifer Springs Quantity, above; see Table 4.4-3). Impact is defined as the probability of a mine's being located within the drainage area of any perched aquifer spring because any mine located in the groundwater drainage area of a perched aquifer spring might introduce impacted water from the mine into the small discharge associated with the spring (see Table 4.4-4). Perched aquifer springs would be expected to show negligible impact where the probability of a mine's being located within the groundwater drainage area of any perched aquifer spring would be less than 5% (East and South parcels; see Table 4.4-4). Moderate impacts are defined as a 5% to 20% probability of a mine's being located within the drainage areas of any perched aquifer spring (North Parcel).
- Quality of flow impacts to R-aquifer springs supporting streams range from none to moderate for the North and East parcels; impacts for the South Parcel range from none to negligible at Havasu and Blue springs, which support Havasu Creek and the Little Colorado River, respectively, and range from none to major for small South Rim springs adjacent to the South Parcel (see

Subsection R-aquifer Springs Quantity, above; see Table 4.4-3). Impacts to Kanab Creek, which is the only perennial stream supported by R-aquifer springs (Kanab and Showerbath) in the North Parcel, would be expected to range from none to moderate (concentrations might at most exceed ambient levels, but not drinking water standards; see Table 4.4-5). There are no perennial streams supported by R-aquifer springs adjacent to the East Parcel because these springs discharge very close to or in the Colorado River channel. For the South Parcel, quality of flow impacts at Havasu and Blue springs, which support flow in Havasu Creek and the Little Colorado River, respectively, would be negligible at most, given the large volume of flow discharging from these springs. For the small springs and stream flow they support along the South Rim of the Grand Canyon adjacent to the South Parcel, no impacts would be expected to occur where mines are located south of the R-aquifer groundwater divide or do not contribute impacted water to the R-aquifer. If any impact were to occur to small South Rim springs, it might be major, given the relatively small volume of flow at these springs.

- If any water quality impact to R-aquifer springs were to occur, the related impact to the Colorado River would be expected to be below the level of natural variation (i.e., negligible impact) as a result of the large volume of water typically carried by the river, which averages a minimum of 1.6 million gpm. Spencer and Wenrich (2011) projected that the change in concentration of dissolved uranium in the Colorado River in response to a hypothetical spill of 30 tons of high-grade uranium ore would be undetectable. No water quality impact to the Colorado River would be expected to occur if no mines contribute impacted water to R-aquifer springs.

Direct impacts to surface waters could occur if water bodies are located in close proximity to mine sites where impacts to soils and/or sediment could occur. Increased erosion might result in negligible increases in suspended sediment and turbidity of runoff near sites of surface disturbance or beyond a few hundred feet from disturbed areas where moderate erosion might occur. However, given that erosion of soils typically occurs only during large rainfall events, these levels of suspended sediments and turbidity would not be expected to exceed ambient levels. Impacts to soil and sediment from mine-related constituents are expected to be generally minor and to occur within close proximity to mine sites based on the impact assessment for soils provided in Section 4.5. Transport of contaminants in stormwater runoff at the mine sites is adequately controlled by perimeter berms surrounding mine sites, which are designed to retain runoff within the mine site or prevent run-on from entering the mine site.[14] Thus, the primary mechanism of contaminant dispersal outside mine perimeters is fugitive dust. Wind-deposited constituents could impact perennial streams or impounded surface waters by direct deposition. Because surface water bodies are scarce in the region, such impacts are unlikely, would be expected to occur only periodically depending on weather conditions, and would be expected to be limited in potential surface area of exposure. Direct impact to ephemeral streams by deposition of wind-transported constituents would be expected to occur where washes are located within a few hundred feet of mine sites. Such direct impacts are equivalent to the impacts to soils/sediment discussed in Section 4.5. Overall, direct impacts to surface waters from distribution of mine-related constituents would be expected to be negligible in all three parcels.

Where distribution of uranium and arsenic in soil and sediment extends beyond the immediate vicinity of mine sites at or above the SRLs,[15] changes in the quality of ephemeral runoff might extend beyond the immediate vicinity of sites of disturbance. These moderate impacts might occur where mines are located in or adjacent to areas of steep topography or large surface water drainage channels (such as canyons). Distributed mine-related constituents could indirectly impact ephemeral surface water by dissolution of the dispersed trace elements from impacted soils and suspension of impacted clay particles in runoff;

[14] The chance of a flood breaching a properly designed, constructed, and maintained berm over 20 years is about 4%, based on the following recurrence interval equation: probability = $1 - (1 - 1/T)^n$, where T is the flood recurrence interval and n is the number of years under consideration (Costa and Baker 1981).

[15] SRLs are 200 ppm for uranium and 10 ppm for arsenic (see Section 4.5).

impacted runoff could mix downgradient with perennial surface water. However, there is a low probability that new mines would be located in or adjacent to areas of steep topography or canyons, based on the relatively few mines that have previously been located in such areas within the proposed withdrawal area (e.g., only the Kanab North Mine and Hack Canyon complex).

An example of water transport of mine-related contaminants from a mine site is provided by the Hack Canyon Mine complex, which consisted of four separate mines located in relatively close proximity within Hack Canyon and tributary canyons. Mineralized mine waste rock was reported to have been transported up to 1 mile downstream of the mine sites as a result of a flood that occurred at the Hack 1 Mine during operations. Review of photographs of the Hack 1 Mine suggests that the mine was not protected by a perimeter berm because of space restrictions at the site (Energy Fuels Nuclear, Inc. 1988b; Otton et al. 2010). Investigations conducted by USGS in 2009 (Otton et al. 2010) indicated that scattered fragments of mineralized waste rock were found up to 0.5 mile downstream of the mines. These fragments could have been dispersed by the 1984 flood or from floods that eroded reclaimed surfaces since mine closure. Sampling of sediments within Hack Canyon by Carver (1999) in September 1998 and May 1999 and by Otton et al. (2010) in fall 2009 indicated that average concentrations of trace elements in fine-grained sediments collected upstream of the mines were approximately equal to average concentrations downstream of the mine. Otton et al. (2010) reports that concentrations of most trace elements approach background levels within about 2 to 3 miles downstream of the mines.

From the investigation of Hack Canyon conducted by the USGS in fall 2009, Otton et al. (2010) concluded that mine-derived particulates in stream sediments are diluted by large quantities of native fine-grained sediments during flooding, thus effectively diluting the contaminants in alluvial sediments to levels indistinguishable from background levels at some distance from the source of the release. Similarly, the impact on the quality of surface water in Kanab Creek and ephemeral runoff in Hack Canyon from dispersal of trace elements adhering to fine-grained particles during fluvial transport would likely result in concentrations approximately at ambient levels because of the dilution effect of storm runoff. Carver (1999) concluded that the primary media for constituent transport is clay and fine sediment in suspension during flooding, rather than dissolved elements being carried in solution. This conclusion is supported by results of Kanab Creek water samples, which indicate little difference between average concentrations of uranium and arsenic in water samples collected at several locations along the creek from Clearwater Spring to the confluence with the Colorado River from 1982 through 1991 (Energy Fuels Nuclear, Inc. 1988c; Taylor et al. 1996; see Appendix G). This result was confirmed by Carver (1999) from water samples collected in Kanab Creek in September 1998 and May 1999 upstream and downstream of the mouth of Hack Canyon. Thus, although the extent of changes in the concentrations of uranium and arsenic in the runoff might extend beyond the immediate vicinity of mine sites, such changes would not be expected to result in increases above ambient levels, except possibly in localized areas where low-flow conditions are persistent in the vicinity of exposed waste rock. This condition is possible only if a release occurs during mining or erosion exposes buried mine waste after reclamation, both of which may have occurred at the Hack Canyon mines. Erosion of reclaimed areas may have also occurred at the Pigeon Mine, which was reclaimed more than 20 years ago; however, dispersion of contaminants in off-site soils and sediments from erosion of reclaimed surfaces by runoff appears to be limited in extent (Otton et al. 2010).

Overall, water quality impacts to surface waters range from negligible to moderate for the North and East parcels and negligible to major for the South Parcel (see Table 4.4-3).

Stream Function

Increased runoff might result from ground disturbance as a result of the removal of vegetation and compaction or re-routing of drainage to accommodate roads and mine-site design features. Large changes in surface stream sediment load and discharge could result in adjustment of stream gradient and/or the cross-sectional area of the active channel and/or cause changes in stream sinuosity. Such changes can result in reduced riparian habitat (e.g., shallow pools or lack of well-developed pool and riffle sequences, reduced bank-stabilizing vegetation, etc.). Such impacts to stream channels typically occur where surface water drainage basins have been subject to denudation following substantial removal of ground cover over large areas, such as that resulting from grazing, drought, and/or wildfires. The area of ground disturbance anticipated in the RFD scenarios would not be expected to encompass a large enough area to generate changes in flow rate and/or sediment loads that would result in substantial impacts on overall stream morphology or function. Although unlikely, moderate effects on stream morphology might occur in areas of steep topography, where the potential for increased erosion is greater. Such impacts might include measurable increases in sediment loads and slight adjustments in channel gradient and/or cross-sectional area. The impacts could occur downgradient of sites of activity and might extend beyond the immediate vicinity of the sites (a few hundred feet) but would be expected to be localized to a relatively short distance along stream channels and could be similar in magnitude to changes resulting from seasonal storms. In general, erosion-related impacts are effectively controlled under existing regulations; therefore, the overall impact to stream function in all three parcels would be expected to be negligible but might be moderate in some locations (see Table 4.4-3).

SURFACE WATER/GROUNDWATER INTERACTION

Surface water/groundwater interaction in the parcel areas includes discharge of groundwater at springs to surface water drainages and recharge of ephemeral, intermittent, and perennial stream flow along surface water drainages. Potential impacts to groundwater that might affect surface water resources have been evaluated in previous discussions for this alternative.

Stream flow on the parcels is chiefly ephemeral and occurs only during snowmelt or stormwater runoff events. Potential for impacts to surface water resources as a result of mining operations has been evaluated in previous discussions for this alternative. Impacts to quantity of recharge water are anticipated to be negligible because significant changes in runoff and infiltration capacity would not be expected because of the relatively small total area of anticipated surface disturbance. Because of the large dilution and attenuation capacity of stormwater runoff, potential water quality impacts from recharge via infiltration through affected surface sediments would be expected to be negligible.

Cumulative Impacts

Potential cumulative impacts to groundwater resources include additional potential changes to the resource condition indicators caused by previous uranium mining-related activities and other activities listed in Section 4.4.1 in the proposed withdrawal area and general surrounding area. Previous uranium mines considered for this analysis are the five reclaimed mines (Hack Canyon 1, 2, and 3; Hermit; Pigeon) on the North Parcel and the partly reclaimed Orphan Lode Mine, located at the South Rim, north of the South Parcel. The RFD scenario describes previous exploration activities (1980–1988) as including 1,211 exploration wells in the Arizona Strip District (North and East parcels) and 900 exploration wells in the Kaibab National Forest (South Parcel). Of these, about one out of every two or three was deeper than 600 feet.

The Jackson Flat Water Supply Storage Project is an off-stream water storage project supplied by an existing diversion dam on Kanab Creek. The project is located about 3 miles south from the town of Kanab, Utah, and about 0.5 mile north from the Arizona-Utah state boundary. The project is anticipated to be complete in 2011 (Kane County Water Conservancy District 2011). The water rights associated with the diversion total 26.7 cubic feet per second, with an annual maximum volume of about 7,561 acre-feet (USACE 2009). Excess water available during periods of low water consumption (winter) will be stored in the reservoir for use during periods of high water consumption (summer). Floods will continue to pass over the diversion dam because that structure is not being upgraded to increase its capacity at this time. In addition, the system is not capable of fully diverting winter flows in Kanab Creek (USACE 2009). The potential impact of the Jackson Flat Water Supply Storage Project on flow in Kanab Creek may be reduction of in-stream flow during the winter and increased irrigation-related recharge of the alluvium during the summer months.

GROUNDWATER

Potential impacts to groundwater from previous uranium mines include potential declines in spring discharge or water levels in wells and introduction of mine drainage to aquifers. Potential decline in present perched aquifer spring discharge or water levels in perched aquifer wells might occur where old mines are located within the groundwater drainage area of perched aquifers; however, equilibrium conditions would be expected to have been re-established at these old mines, so further impacts are unlikely. Similarly, potential declines in regional spring discharge and water levels in R-aquifer wells from previous pumping of R-aquifer mine supply wells would likely have been negligible and would have recovered. Impact to springs from old mines might be somewhat more likely because old mines, particularly those that have not been reclaimed, might provide a continual source of mine drainage; one spring complex has been documented to have mine-related water quality impacts (Horn Spring complex in Grand Canyon National Park).

Additional potential impact to groundwater quality might be caused by previously drilled exploration wells. Exploration wells drilled prior to March 5, 1984, might not necessarily meet the assumption of proper abandonment used for discussion of direct and indirect impacts. However, because of the factors described in Section 4.4.1, it is assumed that the pre-1984, pre-regulation wells represent a negligible impact. Because of the regulations regarding drilling and abandonment for the oil and gas industry [AAC, Title 12, Chapter 7, Oil and Gas Conservation Commission], potential impact from future oil or gas wells would not be expected to contribute to cumulative impacts for the same reasons that exploration wells would not be expected to present a cumulative impact (as described in Section 4.4.1).

Potential impacts to groundwater quantity and quality from non-uranium mining activities might occur where other mines or quarries were, are, or will be established in the groundwater drainage area of perched aquifers. It is assumed that because such mines are not deep, they do not present a risk to the deeper R-aquifer, which is protected by confining layers such as the Hermit Formation. Other mines established in the groundwater drainage area of perched aquifers might impact springs and present a cumulative impact if uranium mines are also located in the perched aquifer spring groundwater drainage area. It is assumed that the magnitude of cumulative impact for individual springs would likely be no greater than the potential impact that might result from the uranium mines because either mine might result in drainage of the aquifer or exceedances of water quality standards. Cumulative impact to perched aquifer wells would be expected to be about the same as direct and indirect impacts for all parcels and across all alternatives because, as discussed in Section 4.4.1, the number of future water wells is expected to be none or few.

Non-uranium mine wells or municipal supply wells could impact the deep regional aquifer if drilled to support future operations or a growing population; however, as discussed previously, installation of additional R-aquifer supply wells is unlikely during the 20-year period of this assessment, except possibly at Tusayan or Valle (presented in Section 4.4.1 and the preceding discussion of Alternative A).

Perched Aquifer Springs

North Parcel: Only one (Pigeon Mine) of the five old uranium mines considered for cumulative impacts on the North Parcel lies within the calculated groundwater drainage area of a perched aquifer spring (Pigeon Spring). No data are available to assess current or past impacts to the spring. A water sample collected by the USGS prior to mining in 1982 showed that the total natural uranium concentration in water from Pigeon spring was 44.0 µg/L (Hopkins et al. 1984b; see Appendix G), which exceeds the EPA drinking water standard (30 µg/L).

Other mines, specifically old copper mines located adjacent to the parcel and eight separate sand and gravel or quarry operations within the parcel, might impact perched aquifer springs. However, only two existing sand and gravel operations and quarries are located near perched aquifer springs. It is not known whether these quarries have impacted any springs. Future shallow mines could be developed in the North Parcel, particularly for gypsum or sand and gravel. Because the impact criteria for perched aquifer springs is based on the probability of a mine's being located in the drainage area of a perched aquifer spring, the probability of this occurring from placement of future non-uranium mines or quarries might increase. This potential increase is difficult to estimate but would not be expected to change the impact category.

The perched aquifer springs along Kanab Creek in the North Parcel have local drainage areas within the parcel and are unrelated and unaffected by flow in Kanab Creek; therefore, the Jackson Flat Water Supply Storage Project does not represent a cumulative impact to perched aquifer springs.

Perched aquifer wells might have a cumulative impact on nearby perched aquifer springs if such springs would also be impacted by either non-uranium mines or uranium mines. Review of Figure 4.4-1 indicates that approximately less than 10 shallow wells occur within the groundwater drainage areas for perched aquifer springs. Impact from perched aquifer wells would be expected to have a much smaller impact than mine openings because their use may be intermittent and the volume of water that may be produced from such wells is limited. Therefore, the cumulative impact from perched aquifer wells would not be expected to change the impact category.

Overall cumulative impacts to North Parcel perched aquifer springs would be expected to be generally moderate.

East Parcel: No previous uranium mines have been developed in the East Parcel. A few old mines may be located along the Vermilion Cliffs, and two sand and gravel and quarry operations are located in the parcel. These mines would not represent a cumulative impact to perched aquifer springs because no springs along the cliffs would be impacted by uranium-mining activities on the parcel and the two mines within the parcel are not near perched aquifer springs. Cumulative impact to East Parcel perched aquifer springs would be expected to be the same as direct and indirect impacts. The threshold criterion for potential impacts to quantity and quality of perched aquifer springs is based on the probability of a mine's being located within the drainage area of the drainage area of a perched aquifer spring, which would increase if more mines were developed in the future (see Table 4.4-1). However, based on the number of existing mines, it is unlikely that enough new mines will be developed to increase the probability of impact above 5%. There would be expected to be no cumulative impact from perched aquifer wells because there are no shallow wells within the groundwater drainage areas for perched aquifer springs (see Figure 4.4-2). Overall cumulative impacts to East Parcel perched aquifer springs would be expected to be the same as direct and indirect impacts (negligible).

South Parcel: The Orphan Lode Mine is located a few miles north of the South Parcel at the South Rim of Grand Canyon. Kolb Spring, which is a perched aquifer spring located about 1 mile southeast from the Orphan Lode Mine near the head of an adjacent surface water drainage developed along the Bright Angel Fault Zone, might be subject to impact from the mine. Given the location of the spring relative to the mine, impacts from the mine are unlikely. No perched aquifer springs are mapped in the vicinity of the Grandview Mine. Other mines in the South Parcel are located southwest and southeast of the Canyon Mine; these mines are a limestone quarry and shallow copper pit mines that are not located in the groundwater drainage areas of a perched aquifer spring, Miller Seep (see Figure 3.4-9). Thus, the impact assessment would not be expected to change from direct and indirect impacts because of the relatively small number of existing non-uranium mines and perched aquifer springs in the South Parcel. Similarly, there would be expected to be no cumulative impact from perched aquifer wells because there are no shallow wells within the groundwater drainage areas for perched aquifer springs (see Figure 4.4-3). Overall cumulative impacts to South Parcel perched aquifer springs would be expected to be the same as direct and indirect impacts (negligible).

R-aquifer Springs and Wells

North Parcel: Three R-aquifer wells were used as a water supply for the five reclaimed mines on the North Parcel. The Hermit Mine well is presently capped, with no pump, and is not used. Records indicate the Hack Mine well and Pigeon Mine well were abandoned by filling with cement. Similarly, non-uranium mine R-aquifer wells do not exist in the North Parcel or vicinity and are not foreseen to be installed during the next 20 years. Therefore, no cumulative impacts to water quantity of the R-aquifer would be expected from R-aquifer wells because the existing wells are either abandoned or not in use. For water quality impacts, the five reclaimed mines on the North Parcel can be factored into the assessment for calculating potential impacts on the chemical quality of the nearest R-aquifer springs by increasing the total number of mines that are assumed to be contributing impacted water to the R-aquifer (see Table 4.4-5) from a range of zero to eight mines to a range of zero to 11 mines (adding half the number of reclaimed mines). Using this method, the projected concentrations in water discharging at Kanab and Showerbath springs range from 0 to 14 µg/L for uranium and from 0 to 3.6 µg/L for arsenic. These concentrations, which represent no impact to moderate impact to water quality as defined in Table 4.4-1, are the same as those for the direct and indirect impact categories given in Table 4.4-3.

It is uncertain to what extent flow in Kanab Creek supports the discharge of R-aquifer springs downstream of the North Parcel. Therefore, the cumulative impact of Jackson Flat Water Supply Storage Project cannot be quantified but would be expected to be small.

East Parcel: No previous uranium mines have been developed in the East Parcel. A few old mines may be located along the Vermilion Cliffs (see Figure 3.4-9), but these mines would not represent a cumulative impact to the R-aquifer because these mines are expected to be shallow. Cumulative impact to the R-aquifer in the East Parcel would be expected to be the same as direct and indirect impacts. There would be no cumulative impact from R-aquifer wells or on R-aquifer wells because no such wells exist in the East Parcel and no non-mine R-aquifer wells are anticipated to be drilled during the next 20 years.

South Parcel: The Orphan Lode and Grandview Mines are located outside the South Parcel and on the opposite side of an R-aquifer groundwater divide from the majority of the parcel. These mines are abandoned and do not use groundwater from the R-aquifer. Therefore, no cumulative impacts to water quantity of the R-aquifer would be expected from these mines. However, there might be a potential cumulative water quality impact for the R-aquifer groundwater basins that drain north from the parcel. If an additional mine were to impact Horn Creek springs, the resultant concentrations of arsenic and uranium might be greater than those documented by Liebe (2003) at some sampling locations. Given the already high concentrations of uranium (up to 400 µg/L) and arsenic (90 µg/L) detected, the addition of new uranium mining activities would not be expected to increase the impact category at Horn Creek springs because they already show a major impact. In addition, it should be noted that it is very unlikely any new mines would be located in the groundwater drainage area of Horn Creek because it is a small spring (reported discharge is about 0.5 gpm) that is located about 4 miles from the parcel boundary.

Two R-aquifer springs are mapped immediately to the southeast (Miner’s or Page Spring) and northwest (O’Neil Spring) from the Grandview Mine (Alter et al. 2009). No data are available from O’Neil Spring; however, data collected between 1981 and 2001 at Miner’s Spring indicate that the average uranium concentration is 3.6 µg/L, and the average arsenic concentration is 18.8 µg/L (see Appendix G). This uranium concentration is consistent with the average of 4 µg/L for all small South Rim R-aquifer springs; however, the arsenic concentration is several µg/L above the average concentration of about 10 µg/L for small R-aquifer springs on the South Rim (see Table 4.4-5). Data for arsenic content in the small South Rim R-aquifer springs are relatively sparse and are not available prior to mining at the Grandview Mine. Other springs in the area not adjacent to mines are reported to contain up to 17 µg/L of arsenic. Thus, although arsenic concentrations in discharge from Miner's Spring are above average, these concentrations are not readily distinguishable from area ambient levels. There are no known potential cumulative impacts from the Grandview Mine with respect to arsenic. Similarly, because uranium concentrations in Miner's Spring are equal to the average ambient level, there are no cumulative impacts with respect to uranium. As with Horn Creek spring, it should be noted that it is very unlikely any new mines would be located in the groundwater drainage area of Miner's Spring because it is a small spring (reported discharge is zero to 1.5 gpm) that is located several miles from the parcel boundary. For the purpose of this analysis, it is assumed that conditions for O'Neil Spring are similar to those for Miner's Spring.

The additional R-aquifer groundwater withdrawals anticipated to result from uranium mining activities (average 7 gpm over 20 years; see Appendix B, Table B-15) would be expected to be considerably smaller than reported in Table 3.4-1 for existing wells at Tusayan, Valle, and the Havasupai Reservation (about 350 gpm). This increase would have a negligible impact on Havasu Springs (29,000 gpm) and would not be expected to result in more than 10 feet of decline in R-aquifer wells in the first 5 years of pumping any mine well (ADWR criteria for acceptable well impact in an AMA). New supply wells might be installed at Tusayan and Valle, or in population centers outside the study area, such as Williams (possibly linked to the Havasu Springs basin) or Flagstaff (possibly linked to the Blue Springs basin). New wells installed to support these growing population centers would represent a much larger and longer-term impact, compared with the relatively small amount of foreseen withdrawal for uranium mines; the number and location of such wells are not reasonably foreseeable. Thus, no cumulative impact is assessed for the potential future demand from population centers. Because no previous uranium mining has occurred in the South Parcel, no cumulative water quality impacts would occur. Potential cumulative impact from future uranium mining might occur in downgradient areas from the South Parcel in the Havasu Springs groundwater basin on state or private lands. Even if such off-parcel mining would equal the projected direct and indirect impacts of the South Parcel for quantity and quality of Havasu Springs, it would not change the impact category given in Table 4.4-3 from the volume of the spring complex.

Overall cumulative impacts to the R-aquifer in the South Parcel would be expected to be the same as those assigned for direct and indirect impacts.

SURFACE WATER

Perennial surface water (base flow) might be subject to additional impacts on water quantity and quality beyond direct and indirect impacts where cumulative impacts to perched aquifer and R-aquifer springs occur. Thus, cumulative impacts to perennial surface water streams are the same as those discussed for perched and R-aquifer springs. Cumulative impact to surface water quality could result if new mines are located immediately adjacent to or within areas of Hack Canyon that are currently impacted by previous mining activities at the Hack Canyon Mine complex. Such impacts would be expected to be moderate, as defined in Table 4.5-1, because impacts from the Hack Canyon mine would be expected to remain the same or decrease from conditions observed by the USGS in fall 2009 (Otton et al. 2010).

Drainages receiving ephemeral surface water runoff might be subject to additional impacts to quantity of flow, quality of flow, and stream function from moderate to major increased runoff, erosion, and subsequent sedimentation. Areas exposed to moderate to major ground disturbance and associated increased runoff might experience severe flash floods, which would be expected to be shorter in duration but much larger in magnitude than for undisturbed areas with similar vegetative and soil properties. Major increased erosion could affect water quality by raising the total suspended sediment content of stormwater runoff. Such large magnitude changes in both ephemeral discharge and sediment loads could adversely impact stream morphology, function, and associated riparian habitats in streams receiving perennial flow. Disturbance and increased soil loss related to past, present, and future activities or conditions other than those outlined in the RFD scenario are potentially several orders of magnitude larger in intensity and areal extent than impacts from activities outlined in the RFD scenario. Addition of uranium mining related activities in the RFD scenario would result in a very small contribution to the overall level of disturbance and soil loss in the proposed withdrawal area. Thus, other actions or conditions listed in Section 4.4.1, particularly past wildfires, livestock grazing, and drought, could generate moderate to major impacts to ephemeral runoff, regardless of impacts from RFD scenario–related activities. Similarly, the Jackson Flat Water Supply Storage Project might result in reduced stream flow in Kanab Creek during winter months, and this potential reduction would be expected to be much greater than the amount of water retained within the individual projected mine sites. More information regarding land disturbance in the study area is presented in Section 4.5. Erosion impacts would be expected to be effectively controlled for all activities approved and reviewed by federal and state agencies with jurisdiction in the area. Similarly, former, current, and future exploration drilling sites for uranium or other minerals (including water) also would not be expected to generate severe ground disturbance; even if some disturbance occurs, it would be reclaimed following the conclusion of the project.[16]

4.4.5 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

The definition of direct and indirect impacts for Alternative B is the same as described for Alternative A.

GROUNDWATER

Resource condition indicators for groundwater resources for Alternative B are the same as described for Alternative A. Total number of existing and anticipated mines for Alternative B is 10 mines for the North Parcel, no mines for the East Parcel, and one mine for the South Parcel (see Appendix B, Table B-22). Projected total water use for these mines is 105 mgal (average of 10 gpm for 20 years) for the North Parcel, 0 gallons for the East Parcel, and 11 mgal (average of 1 gpm for 20 years) for the South Parcel (see Appendix B, Table B-22). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the protective buffer area calculations for perched aquifer springs described in Section 4.4.1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are likely located within the groundwater drainage area for a perched aquifer spring (see Figure 4.4-1). However, it is not certain where the other seven mines anticipated in Appendix B will be located. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 5.4% (see Table 4.4-4), which is classified as a moderate impact according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2). Compared with projections under Alternative A, the probability of impact is reduced from 13.3% to 5.4%, which does not correspond to a change in the impact category (moderate).

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[16] According to the RFD scenarios (see Appendix B), disturbance for exploration drilling does not include disturbance related to temporary road construction because sites for breccia pipe exploration are typically reached by overland travel.

East Parcel Springs: No mines are included in the East Parcel for Alternative B. Thus, there is no impact projected, according to the criteria given in Table 4.4-1. Compared with projections under Alternative A, the probability of impact is reduced from 1.3% to 0%, which corresponds to a change in the impact category from negligible to none.

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the protective buffer area calculated for the sole perched aquifer spring (see Figure 4.4-3). Thus, there is no impact projected, according to the criteria given in Table 4.4-1. Compared with projections under Alternative A, the probability of impact is reduced from 0.2% to 0%, which corresponds to a change in the impact category from negligible to none.

Wells: Following the analysis given for Alternative A, potential impact to the quantity and quality of discharge from perched aquifer wells was assumed to be directly related to the anticipated number of mines for each parcel. It was assumed that zero to half of the anticipated number of mines might be located within the perched groundwater zone that supports a well for the 20-year period of this analysis. Based on this assessment, it was assumed that this number of mines is zero to 5 for the North Parcel, zero for the East Parcel, and zero to one for the South Parcel. These assumptions are classified as no impact to negligible impact for the North and South parcels and no impact for the East Parcel, according to the criteria given in Table 4.4-1. Duration of these impacts would likely range from short term to long term (defined in Table 4.4-2).

The impact projections for Alternative B compare with those for Alternative A as follows:

- North Parcel. The maximum number of mines that might impact perched aquifer wells is reduced from 11 to 5, which corresponds to a change in the upper-end impact category from major to negligible.
- East Parcel. The maximum number of mines that might impact perched aquifer wells is reduced from 1 to none, which corresponds to a change in the upper-end impact category from negligible to none.
- South Parcel. The maximum number of mines that might impact perched aquifer wells is reduced from 4 to 1, which does not correspond to a change in the upper-end impact category (negligible).

R-aquifer Springs Quantity

North Parcel: Following a similar analysis to the one given for Alternative A, potential impacts to quantity of discharge from the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) are assessed as follows. The combined average groundwater demand over 20 years for the 10 mines predicted for the North Parcel is 10 gpm (see Appendix B), which is about 2.1% of the aggregate discharge of 470 gpm from Kanab and Showerbath springs (see Appendices E and G). This represents a potential decrease in spring discharge that is greater than zero, but less than 2.1%. Therefore, even if it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from these springs, the decrease would likely be less than the error of measurement for commonly used stream gaging methods (Harmel et al. 2006). Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Compared with projections under Alternative A, the decrease in discharge from R-aquifer springs is reduced from less than 4.5% to less than 2.1%, which does not correspond to a change in the impact category (negligible).

Potential impacts to the Virgin River watershed are the same as those projected for Alternative A.

East Parcel: No mines are included in the East Parcel for Alternative B. Thus, there is no impact projected, according to the criteria given in Table 4.4-1. Compared with projections under Alternative A, the decrease in discharge from R-aquifer springs is reduced from less than 0.1% to 0%, which corresponds to a change in the impact category from negligible to none.

South Parcel: Following a similar analysis to the one given for Alternative A, the sole existing mine well (Canyon) on the South Parcel is located more than 5 miles south from the groundwater divide (see Figure 4.4-3), in the groundwater basin that drains to the distant Havasu Springs. The mine site is not located along any major fault zones. Average discharge from Havasu Springs is about 29,000 gpm. The combined average groundwater demand over 20 years for this mine is 1 gpm (see Appendix B). The projected decrease in discharge at Havasu Springs as a result of this mine water demand would be less than 0.01% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Mine wells would not be expected to result in decreases in the discharge from Blue Springs or South Rim springs because mines would not be expected to be located within their respective groundwater drainage areas.

These impact projections compare with those for Alternative A as follows:

- Decrease in discharge from Havasu Springs would be reduced from less than 0.1% to less than 0.01%, which does not correspond to a change in the impact category (negligible).
- Decrease in discharge from Blue Springs would be reduced from less than 0.1% to 0%, which corresponds to a change in the impact category from negligible to none.
- Decrease in discharge from Hermit and Indian Garden spring complexes would be reduced from less than 2% to 0%, which corresponds to a change in the impact category from negligible to none.
- Decrease in discharge from small South Rim springs would be reduced from a potential maximum of 100% to 0%, which corresponds to a change in the impact category from major to none.

R-aquifer Wells Quantity

Following the analysis given for Alternative A, no new non-mine R-aquifer wells are projected to be drilled on or near the North and East parcels for the 20-year period of this analysis. It is possible that the small population centers at Tusayan and Valle might drill additional R-aquifer production wells to meet increases in demand for public water supply. Based on the location of existing wells and the projected construction of new wells, it is not likely that mines would be located sufficiently near a non-mine R-aquifer water supply well to cause more than a negligible water level drawdown impact to the non-mine well, according to the criteria given in Table 4.4-1. Because it is anticipated that no more than one mine would be in operation (see Appendix B, Section B.8.1.7), the potential total drawdown impact to existing wells at Tusayan, Valle, or more distant areas from pumping mine wells would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2). Thus, drawdown impacts to R-aquifer wells are projected to be about the same as those projected under Alternative A.

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative B analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: The following assumptions were made for this assessment:

1. Zero to half of the 10 mines (five mines) predicted for the North Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs).
2. The average ambient concentration of dissolved uranium in the aggregate discharge (470 gpm) from these springs is 4.9 µg/L, and the concentration of dissolved arsenic is about 2 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium at the springs ranges from 4.9 to 9.0 µg/L, and the projected concentration of dissolved arsenic ranges from 2 to 3 µg/L (see Table 4.4-5). The smaller value of each range equals the ambient concentration. None of these concentrations exceed the EPA MCLs for drinking water (30 µg/L for uranium; 10 µg/L for arsenic) for humans, but the larger values of each range do represent increases from the ambient concentrations. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife.

Compared with projections under Alternative A, the maximum resultant concentration at R-aquifer springs is reduced from 14 µg/L to 9.0 µg/L for uranium and from 4 µg/L to 3 µg/L for arsenic, which does not correspond to a change in the upper-end impact category (moderate).

East Parcel: No mines are included in the East Parcel for Alternative B. Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

Compared with projections under Alternative A, the maximum resultant uranium concentration at R-aquifer springs is reduced from 1.8 µg/L to the estimated ambient concentration (1.7 µg/L) because no mines would be expected to contribute impacted water to the R-aquifer, which corresponds to a change in the upper-end impact category from moderate to none. The maximum projected arsenic concentration is the same as projected under Alternative A (both projected to not exceed estimated ambient concentration of 10 µg/L).

South Parcel: The following assumptions were made for this assessment:

1. Zero to one mine predicted for the South Parcel is assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest downgradient R-aquifer springs (Havasu Springs) undiminished. The discharge used in the calculations for the Havasu Springs complex is 29,000 gpm (see Table 4.4-5).
2. The average ambient concentration of dissolved uranium is about 6 µg/L in the discharge from Havasu Springs, and the average ambient concentration of dissolved arsenic is about 10 µg/L (see Table 4.4-5).
3. No mines would be expected to contribute impacted water Blue Springs or South Rim springs because mines would not be expected to be located within their respective groundwater drainage areas.

The resulting projected total concentration of dissolved uranium for Havasu Springs is 6 µg/L, and the projected concentration of dissolved arsenic is 10 µg/L (see Table 4.4-5). None of these concentrations exceed the ambient levels. The ambient arsenic concentration for Havasu Springs is equal to the EPA MCL for drinking water (10 µg/L) for humans. These results would represent a range from no impact to negligible impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife.

These impact projections compare with those for Alternative A as follows:

- The maximum resultant uranium and arsenic concentration at Havasu Springs is unchanged because the projected concentration of uranium and arsenic under Alternative A also do not exceed the ambient concentration. The upper-end impact category is also unchanged (negligible) because at least one mine might contribute impacted water to the R-aquifer in the Havasu Springs groundwater drainage area.
- The maximum resultant uranium and arsenic concentration at Blue Springs is unchanged because the projected concentration of uranium and arsenic under Alternative A also do not exceed ambient levels; however, because no mines would be expected to contribute impacted water to the R-aquifer in the Blue Springs groundwater drainage area, the upper-end impact category changes from negligible to none.
- The maximum resultant uranium concentration is reduced from 4 µg/L at the Hermit complex and 5 µg/L at the Indian Garden complex, to the estimated ambient concentration (3 µg/L), which corresponds to a change in the upper-end impact category from moderate to none because no mines would be expected to contribute impacted water to the R-aquifer in the groundwater drainage areas for these springs. The maximum projected arsenic concentration is unchanged because under Alternative A it is projected to not exceed the estimated ambient concentration of 10 µg/L.

The maximum resultant concentration at small South Rim springs is reduced from 70 µg/L for uranium and 30 µg/L for arsenic to estimated ambient concentrations (4 µg/L and 10 µg/L, respectively); this corresponds to a change in the upper-end impact category from major to none because no mines would be expected to contribute impacted water to the R-aquifer in the groundwater drainage areas for these springs.

R-aquifer Wells Quality

Following the same analysis given for Alternative A, the potential impacts and duration for Alternative B are the same as those assigned to Alternative A.

SURFACE WATER

The nature of impacts to surface waters would be expected to be the same as described for Alternative A; however, the magnitude of the impacts would be considerably smaller because of less mineral development and the reduction or elimination of mines in Alternative B that might be located in areas with sensitive soils or in areas near springs and streams.

Evaluation of the impact thresholds described in Table 4.4-1 for surface waters in the North Parcel are the same as for Alternative A because substantial mining activity is still foreseen to occur, regardless of the proposed withdrawal (see Table 4.4-3).

No impacts to surface waters would occur in the East Parcel because no uranium mining is foreseen under Alternative B. In the South Parcel, only the Canyon Mine would be developed; therefore, the only perennial stream flow under Alternative B that might be impacted is the stream below Havasu Springs; water quantity and quality impacts would be expected to be at most negligible because of the large discharge of the springs. No water quality impact to perennial stream flow as a result of discharge from Havasu Springs would occur in the event that no mines contribute impacted water to the R-aquifer, as discussed for Alternative A. Impacts to ephemeral streams and stream function associated with the

Canyon Mine would also be expected to be negligible because the mine site is not in an area of steep topography. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Compared to projected impacts under Alternative A for the East Parcel, the impact category range changes from negligible–moderate to none. Compared to projected impacts under Alternative A for the South Parcel: the impact category range for streams supported by Blue Springs or South Rim springs changes from negligible–major to none; the impact category range for all other streams (quantity, quality, and function) changes from negligible–moderate to negligible.

Impacts to the Colorado River would be expected to be negligible (unchanged from Alternative A); duration of all potential impacts to the Colorado River would likely range from short term to long term.

Cumulative Impacts

GROUNDWATER

Potential cumulative impacts to springs and wells in all three parcels would be expected to be the same as direct and indirect impacts for Alternative B because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories. However, compared to Alternative A, overall cumulative impacts to groundwater would be expected to be smaller in magnitude. Under Alternative B, fewer uranium mines would be developed, thus this alternative will result in a reduction in cumulative impacts to groundwater as compared to the cumulative impacts discussed under Alternative A.

SURFACE WATER

Potential cumulative impacts to quality and quantity of surface waters in all three parcels would be expected to be the same as direct and indirect impacts for Alternative B because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories.
The nature of potential cumulative impacts to stream function would the same as described for Alternative A; however, the magnitude would be expected to be considerably less because of less mineral development. The decrease in the magnitude of the impact would be expected to be directly proportional to the decrease in disturbed acreage provided in the RFD scenario and discussed in Section 4.5.
Under Alternative B, fewer uranium mines would be developed, thus this alternative will result in a reduction in cumulative impacts to surface water as compared to the cumulative impacts discussed under Alternative A.

4.4.6 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Direct and Indirect Impacts

The definitions of direct and indirect impacts for Alternative C are the same as described for Alternative A.

GROUNDWATER

Resource condition indicators for groundwater resources for Alternative C are the same as described for Alternative A. Total number of existing and anticipated mines for Alternative C is 13 mines for the North Parcel, one mine for the East Parcel, and four mines for the South Parcel (see Appendix B, Table B-31).

Projected total water use for these mines is 137 mgal (average of 13 gpm for 20 years) for the North Parcel, 11 mgal (average of 1 gpm for 20 years) for the East Parcel, and 42 mgal (average of 4 gpm for 20 years) for the South Parcel (see Appendix B, Table B-31). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the protective buffer area calculations for perched aquifer springs described in Section 4.4.1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are likely located within the groundwater drainage area for a perched spring (see Figure 4.4-1). It is not known where the other 10 mines estimated in Appendix B may be located. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 6.7% (see Table 4.4-4), which is classified as a moderate impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2). Compared with projections under Alternative A, the probability of impact is reduced from 13.3% to 6.7%, which does not correspond to a change in the impact category (moderate).

East Parcel Springs: All seven of the perched aquifer springs mapped in the East Parcel (see Figure 4.4-2) are located within the Alternative C proposed withdrawal area. Thus, there is no impact projected, according to the criteria given in Table 4.4-1. Compared with projections under Alternative A, the probability of impact is reduced from 1.3% to 0%, which corresponds to a change in the impact category from negligible to none.

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the protective buffer area calculated for a perched aquifer spring (see Figure 4.4-3). There is one perched aquifer spring mapped in the South Parcel (see Figure 4.4-3); however, it is located within the Alternative C proposed withdrawal area. Thus, there is no impact projected, according to the criteria given in Table 4.4-1. Compared with projections under Alternative A, the probability of impact is reduced from 0.2% to 0%, which corresponds to a change in the impact category from negligible to none.

Wells: Following the analysis given for Alternative A, potential impact to the quantity and quality of discharge from perched aquifer wells was assumed to be directly related to the anticipated number of mines for each parcel. It was assumed that zero to half of the anticipated number of mines might be located within the perched groundwater zone that supports a well for the 20-year period of this analysis. Based on this assessment, it was assumed that this number of mines is zero to seven for the North Parcel, zero to one for the East Parcel, and zero to two for the South Parcel. These assumptions are classified as no impact to moderate impact for the North Parcel, and no impact to negligible impact for the East and South parcels, according to the criteria given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

The impact projections for Alternative C compare with those for Alternative A as follows:

- North Parcel. The maximum number of mines that might impact perched aquifer wells is reduced from 11 to 7, which corresponds to a change in the upper-end impact category from major to moderate.
- East Parcel. No change in the maximum number of mines that might impact perched aquifer wells.
- South Parcel. The maximum number of mines that might impact perched aquifer wells is reduced from 4 to 2, which does not correspond to a change in the upper-end impact category (negligible).

R-aquifer Springs Quantity

North Parcel: Following a similar analysis to the one given for Alternative A, the combined average groundwater demand over 20 years for the 13 mines predicted for the North Parcel is 13 gpm (see Appendix B), which is about 2.8% of the aggregate discharge of 470 gpm from Kanab and Showerbath springs (see Appendices E and G). This represents a potential decrease in spring discharge that is greater than zero, but less than 2.8%. Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Compared to projections under Alternative A, the decrease in discharge from R-aquifer springs is reduced from less than 4.5% to less than 2.8%, which does not correspond to a change in the impact category (negligible).

Potential impacts to the Virgin River watershed are the same as projected for Alternative A.

East Parcel: Following a similar analysis to the one given for Alternative A, the combined average groundwater demand over 20 years for the 1 mine predicted for the East Parcel is 1 gpm (see Appendix B), which is less than 0.05% of the aggregate discharge of 3,700 gpm from the Fence Fault complex (see Appendices E and G). Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Compared to projections under Alternative A, the decrease in discharge from R-aquifer springs is reduced from less than 0.1% to less than 0.05%, which does not correspond to a change in the impact category (negligible).

South Parcel: Following a similar analysis to the one given for Alternative A, the sole existing mine well (Canyon) on the South Parcel is located more than 5 miles south from the groundwater divide (see Figure 4.4-3) in the groundwater basin that drains to the distant Havasu Springs. It is not known where the other three anticipated mines estimated in the RFD scenarios may be located; however, based on the location of the Alternative C proposed withdrawal boundary, the other three anticipated wells must be several miles south of the groundwater divide in the Havasu Springs groundwater basin. Therefore, the combined average groundwater demand over 20 years for the 4 mines predicted for the South Parcel is 4 gpm (see Appendix B), which is less than 0.05% of the average discharge of 29,000 gpm from Havasu Springs (see Appendices E and G). Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Compared to projections under Alternative A, the decrease in discharge from R-aquifer springs is reduced from less than 0.1% to less than 0.05%, which does not correspond to a change in the impact category (negligible).

R-aquifer Wells Quantity

Following the same analysis given for Alternative A, the potential impacts and duration for Alternative C are the same as those assigned to Alternatives A and B. Thus, drawdown impacts to R-aquifer wells are projected to be the about same as those projected under Alternative A.

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative C analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: The following assumptions were made for this assessment:

1. Zero to half of the 13 mines (seven mines) predicted for the North Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs).
2. The average ambient concentration of dissolved uranium in the aggregate discharge (470 gpm) from these springs is 4.9 µg/L, and the concentration of dissolved arsenic is about 2 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium at the springs ranges from 4.9 to 11 µg/L, and the projected concentration of dissolved arsenic ranges from 2 to 3 µg/L (see Table 4.4-5). The smaller value of each range equals the ambient concentration. None of these concentrations exceed the EPA MCLs for drinking water (30 µg/L for uranium; 10 µg/L for arsenic) for humans, but the larger values of each range do represent increases from the ambient concentrations. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife.

Compared to projections under Alternative A, the maximum resultant concentration at R-aquifer springs is reduced from 14 µg/L to 11 µg/L for uranium and from 4 µg/L to 3 µg/L for arsenic, which does not correspond to a change in the upper-end impact category (moderate).

East Parcel: The assumptions, results, and assigned impact category and duration are the same for Alternative C as those described for Alternative A (see Tables 4.4-3 and 4.4-5).

South Parcel: The assumptions, results, and assigned impact category and duration are the same for Alternative C as those described for Alternative B, except that the assumed maximum number of mines that might contribute impacted water to the R-aquifer (Havasu Springs only) is two rather than one (see Tables 4.4-3 and 4.4-5). The small increase in the number of mines potentially contributing impacted water to the R-aquifer does not result in a significant change in the calculation of maximum resulting concentrations compared to the results for Alternative B.

R-aquifer Wells Quality

Following the same analysis given for Alternative A, the potential impacts and duration for Alternative C are the same as those assigned to Alternatives A and B.

SURFACE WATER

The nature of impacts to surface waters would be the same as described for Alternative A; however, the magnitude would be expected to be somewhat smaller because of less mineral development and the reduction or elimination of mines under Alternative C that might be located in areas with sensitive soils or in areas near springs and streams. Evaluation of the impact thresholds described in Table 4.4-1 for surface waters in the North Parcel are the same as under Alternative A because substantial mining activity is still foreseen to occur, regardless of the proposed withdrawal (see Table 4.4-3).

There are no perennial streams supported by R-aquifer springs adjacent to the East Parcel because these springs discharge very close to or in the Colorado River channel; no impacts would be expected to occur to perennial streams that may be supported by perched aquifer springs in the East Parcel. The only perennial stream flow associated with the South Parcel under the Alternative C proposed withdrawal area that might be impacted is supported by Havasu Springs, which discharges large volumes of water from the R-aquifer, and thus would be expected to exhibit no more than a negligible impact. No water quality impact to this perennial stream from the springs would occur in the event that no mines contribute impacted water to the R-aquifer, as discussed under Alternative A. Impacts to ephemeral streams and stream function in the East and South parcels would also be expected to be negligible at most because mines would not be expected to be located in areas of sensitive soils or steep topography. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Compared to projected impacts under Alternative A for the East Parcel, the impact category range changes from negligible–moderate to negligible. Compared to projected impacts under Alternative A for the South Parcel: the impact category range for streams supported by Blue Springs or South Rim springs changes from negligible–major to none; the impact category range for all other streams (quantity, quality, and function) changes from negligible–moderate to negligible.

Impacts to the Colorado River would be expected to be negligible (unchanged from Alternative A); duration of all potential impacts to the Colorado River would likely range from short term to long term.

Cumulative Impacts

GROUNDWATER

Potential cumulative impacts to springs and wells in all three parcels would be expected to be the same as direct and indirect impacts for Alternative C because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories. However, compared to Alternative A, overall cumulative impacts would be expected to be smaller in magnitude.

SURFACE WATER

Potential cumulative impacts to quality and quantity of surface waters in all three parcels would be expected to be the same as direct and indirect impacts for Alternative C because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3). The nature of potential cumulative impacts to stream function would the same as described for Alternative A; however, the magnitude would be expected to be somewhat less because of less mineral development. The decrease in the magnitude of the impact would be expected to be directly proportional to the decrease in disturbed acreage provided in the RFD scenario and discussed in Section 4.5.

4.4.7 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

The definitions of direct and indirect impacts for Alternative D are the same as those described for Alternative A.

GROUNDWATER

Resource condition indicators for groundwater resources for Alternative D are the same as those described for Alternative A. Total number of existing and anticipated mines for Alternative D is 20 mines for the North Parcel, one mine for the East Parcel, and five mines for the South Parcel (see Appendix B, Table B-40). Projected total water use for these mines is 210 mgal (average of 20 gpm for 20 years) for the North Parcel, 11 mgal (average of 1 gpm for 20 years) for the East Parcel, and 53 mgal (average of 5 gpm for 20 years) for the South Parcel (see Appendix B, Table B-40). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the protective buffer area calculations for perched aquifer springs described in Section 4.4.1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are likely located within the groundwater drainage area for a perched aquifer spring (see Figure 4.4-1). It is not known where the other 17 mines estimated in Appendix B may be located. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 10.8% (see Table 4.4-4), which is classified as a moderate impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2). Compared to projections under Alternative A, the probability of impact is reduced from 13.3% to 10.8%, which does not correspond to a change in the impact category (moderate).

East Parcel Springs: All seven of the perched aquifer springs mapped in the East Parcel (see Figure 4.4-2) are located within the Alternative D proposed withdrawal area. Thus, there is no impact projected, according to the criteria given in Table 4.4-1. Compared to projections under Alternative A, the probability of impact is reduced from 1.3% to 0%, which corresponds to a change in the impact category from negligible to none.

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the protective buffer area calculated for a perched aquifer spring (see Figure 4.4-3). It is not known where the other four anticipated mines estimated in the RFD scenario may be located. There is one perched aquifer spring mapped in the South Parcel (see Figure 4.4-3). Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the South Parcel is 0.3%, which is classified as a negligible impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2). Compared to projections under Alternative A, the probability of impact is about the same, 0.2% compared to 0.3%, which does not correspond to a change in the impact category (negligible).

Wells: Following the analysis given for Alternative A, potential impacts from Alternative D to the quantity and quality of discharge from perched aquifer wells were determined to be the same impact categories as were assigned for Alternative C (see Table 4.4-3).

The impact projections for Alternative D compare with those for Alternative A as follows:

- North Parcel. The maximum number of mines that might impact perched aquifer wells is reduced from 11 to 10, which corresponds to a change in the upper-end impact category from major to moderate.
- East Parcel. No change in the maximum number of mines that might impact perched aquifer wells.
- South Parcel. The maximum number of mines that might impact perched aquifer wells is reduced from 4 to 3, which does not correspond to a change in the upper-end impact category (negligible).

R-aquifer Springs Quantity

North Parcel: Following a similar analysis to the one given for Alternative A, the combined average groundwater demand over 20 years for the 20 mines predicted for the North Parcel is 20 gpm (see Appendix B), which is about 4.3% of the aggregate discharge of 470 gpm from Kanab and Showerbath springs (see Appendices E and G). This represents a potential decrease in spring discharge that is greater than zero, but less than 4.3%. Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Compared to projections under Alternative A, the decrease in discharge from R-aquifer springs is reduced from less than 4.5% to less than 4.3%, which does not correspond to a change in the impact category (negligible).

Potential impacts to the Virgin River watershed are the same as projected for Alternative A.

East Parcel: The analysis, results, and assigned impact category and duration were the same for Alternative D as were described for Alternative C (see Table 4.4-3).

South Parcel: The analysis, results, and assigned impact category and duration were the same for Alternative D as were described for Alternative C (see Table 4.4-3), except that the total groundwater demand over 20 years for the 5 mines predicted for the South Parcel is 5 gpm, rather than 4 gpm (results in a very small potential change in spring discharge compared to Alternative C).

R-aquifer Wells Quantity

Following the same analysis given for Alternative A, the potential impacts for Alternative D are the same as those assigned to Alternatives A, B, and C (see Table 4.4-3). Thus, drawdown impacts to R-aquifer wells are projected to be the about same as those projected under the other alternatives.

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative D analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: The following assumptions were made for this assessment:

1. Zero to half of the 20 mines (10 mines) predicted for the North Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs).
2. The average ambient concentration of dissolved uranium in the aggregate discharge (470 gpm) from these springs is 4.9 µg/L, and the concentration of dissolved arsenic is about 2 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium at the springs ranges from 4.9 to 13 µg/L, and the projected concentration of dissolved arsenic ranges from 2 to 3 µg/L (see Table 4.4-5). The smaller value of each range equals the ambient concentration. None of these concentrations exceed the EPA MCLs for drinking water (30 µg/L for uranium; 10 µg/L for arsenic) for humans, but the larger values of each range do represent increases from the ambient concentrations. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife.

Compared to projections under Alternative A, the maximum resultant concentration at R-aquifer springs is reduced from 14 µg/L to 13 µg/L for uranium and from 4 µg/L to 3 µg/L for arsenic, which does not correspond to a change in the upper-end impact category (moderate).

East Parcel: The assumptions, results, and assigned impact category and duration were the same for Alternative D as were described for Alternatives A and C (see Tables 4.4-3 and 4.4-5).

South Parcel: The assumptions, results, and assigned impact category and duration are the same for Alternative D as those described for Alternatives B and C, except that the assumed maximum number of mines that might contribute impacted water to the R-aquifer (Havasu Springs only) is three rather than one or two (see Tables 4.4-3 and 4.4-5). The small increase in the number of mines potentially contributing impacted water to the R-aquifer does not result in a significant change in the calculation of maximum resulting concentrations compared to the results for Alternative B and C.

R-aquifer Wells Quality

Following the same analysis given for Alternative A, the potential impacts for Alternative D are the same as were assigned to Alternatives A, B, and C.

SURFACE WATER

The nature of impacts to surface waters would be the same as described for Alternative A; however, the magnitude would be expected to be slightly smaller because of less mineral development and the reduction or elimination of mines under Alternative D that might be located in areas with sensitive soils or in areas near springs and streams. Evaluation of the impact thresholds described in Table 4.4-1 for surface waters in the North Parcel is the same as under Alternative A because substantial mining activity is still foreseen to occur, regardless of the proposed withdrawal (see Table 4.4-3). There are no perennial streams supported by R-aquifer springs adjacent to the East Parcel because these springs discharge very close to or in the Colorado River channel; no impacts would be expected to occur to perennial streams that may be supported by perched aquifer springs in the East Parcel. As under Alternatives B and C, the only perennial streamflow associated the South Parcel that might be impacted is supported by Havasu Springs; this stream would be expected to exhibit no more than a negligible impact. Impacts to ephemeral streams and stream function in the East Parcel would also be expected to be negligible at most because mines would not be expected to be located in areas of sensitive soils or steep topography. However, compared with the proposed withdrawal under Alternative C, more areas of steep topography, such as the Red Butte area and various drainage channels identified with a high erosion risk, are open to mineral development in the South Parcel (as discussed in the direct and indirect impact analysis for soil resources in Section 4.5). Given this and the larger number of mines foreseen under Alternative D in the South Parcel (five), mines might be located in one of these sensitive areas. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Compared to projected impacts under Alternative A for the East Parcel, the impact category range changes from negligible–moderate to negligible. Compared to projected impacts under Alternative A for the South Parcel: the impact category range for streams supported by Blue Springs or South Rim springs changes from negligible–major to none; the impact category range for all other streams (quantity, quality, and function) does not change (negligible–moderate).

Impacts to the Colorado River would be expected to be negligible (unchanged from Alternative A); duration of all potential impacts to the Colorado River would likely range from short term to long term.

Cumulative Impacts

GROUNDWATER

Potential cumulative impacts to springs and wells in all three parcels would be expected to be the same as direct and indirect impacts for Alternative D because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories. However, compared to Alternative A, overall cumulative impacts would be expected to be smaller in magnitude.

SURFACE WATER

Potential cumulative impacts to quality and quantity of surface waters in all three parcels would be expected to be the same as direct and indirect impacts for Alternative D because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3). The nature of potential cumulative impacts to stream function would the same as described for Alternative A; however, the magnitude would be expected to be slightly less because of less mineral development. The decrease in the magnitude of the impact would be expected to be directly proportional to the decrease in disturbed acreage provided in the RFD scenario and discussed in Section 4.5.

4.5 SOIL RESOURCES

Soil resources are an important component of the environment that provides a growth medium to support vegetation for wildlife habitat and forage for cattle. Properly maintained soils also have a direct relationship to overall watershed function by regulating sedimentation and the infiltration and storage of precipitation (runoff control). This section evaluates impacts to soil resources that would be caused by the construction, operation, and maintenance of exploration sites, uranium mine facilities, and associated infrastructure within the three proposed withdrawal parcels. A profile of impacts on soil resources was developed based on NRCS soil survey and TES data, site investigations, review of existing literature, and information provided by the BLM, Forest Service, and other agencies. The magnitude of soil impacts was determined through consideration of topography, soil types, foreseeable future mine development for each proposed withdrawal parcel, and a review of environmental assessment results of existing mine sites in the North Parcel. The largest impacts are removal of vegetation and changes in soil physical properties, such as soil compaction, resulting from disturbance of the land surface, potential increased soil erosion, and potential degradation of soil chemical quality by way of the release of contaminants during mining operations. In general, the degree of impact to soil resources under each alternative is related to the anticipated number of exploration boreholes, roads, and power lines and the total number of anticipated mines because the total disturbed acreage and the degree of potential exposure to the environment of mine waste rock and ore depend on the magnitude of mining-related activities. The magnitude, extent, and duration of impacts to soil resources for specific exploration or mining development depend on the amount of disturbed surface area exposed to water and wind, soil types affected, topography of the area, methods of mine and road construction employed, duration of exploration or mining operations, and success of reclamation efforts at each area of operation.

4.5.1 Impact Assessment Methodology and Assumptions

Condition indicator criteria used to evaluate the type and magnitude of soil-related impacts relative to the different proposed withdrawal parcels and alternatives are as follows:

- **Soil Disturbance.** Soils to be disturbed for installation of mine facilities, drill sites, access roads, and power lines would be adversely impacted because disturbed areas may be difficult to re-establish, which could result in a loss of productivity. The indicator values are the anticipated acreage (area) of disturbed soils.
- **Soil Erosion.** Removal of vegetation, soil compaction, and changes in drainage patterns related to anticipated surface disturbance could result in increased runoff and generation of fugitive dust, which contribute to soil loss and loss of productivity. Increased erosion might generate increased

sedimentation in downstream areas. The indicators are qualitative evaluations of potential increased erosion rates relative to undisturbed conditions and the estimated extent of the impact, as modified by soil properties and topography.

- **Soil Contamination.** Potential distribution of contaminants in soil could result from erosion and subsequent deposition of mine waste-rock or ore from water and/or wind action, or leakage from detention ponds in the vicinity of each mine site. Indicators are expected levels of mine-related contaminants in soil, compared with background levels and SRLs.

A qualitative approach was used to assess the potential impact of existing mines and additional anticipated mining activities as outlined in Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios; each condition indicator criterion was evaluated in terms of the estimated or potential magnitude or intensity and extent of the impact. Impacts from surface disturbance are most easily measured because the disturbance itself is the impact. However, accelerated erosion that results in actual soil loss or distribution of contaminants in soil is difficult to assess because such impacts depend on site-specific conditions and effectiveness of design features implemented to control impacts to soil. Thus, these impacts are discussed in terms of potential or likely effects, based on available information from past and current mining activities in the proposed withdrawal parcels.

Direct impacts were considered to be only those impacts occurring during mine development and operations within the boundaries of mining-related work sites and associated infrastructure. Indirect impacts were considered to be impacts occurring off-site or residual impacts occurring after reclamation. Past, current, and future actions or conditions occurring in the parcels were reviewed to assess the potential cumulative impact that might result when impacts from these actions overlap with impacts from mining-related activities outlined in the RFD scenarios. Impacts were analyzed within the boundaries of the three proposed withdrawal parcels only. Based on studies of 1980s-era mining in the North Parcel, it is unlikely that impacts to soil resources would extend beyond the boundaries of the parcels because of mine site features designed to control soil impacts, unless a specific mine is located very close to an area with steep topography or within or near drainage channels.

Impact assessment categories are defined as follows: potential durations of impacts to soil resources are the same as defined in Table 4.1-2. Durations of impacts are analyzed separately from the intensity and extent of impacts. Tables 4.5-1 and 4.5-2 provide definitions of impact magnitude and duration, respectively, as they relate to soundscapes.

Table 4.5-1. Magnitude and Degrees of Effects on Soil Resources

Attribute of Effect	Description Relative to Soil Resources
No Impact*	No changes in baseline soil resource conditions would occur. No acreage would be disturbed. Soil erosion would be at the regional baseline soil loss rate. Levels of contaminants in soil would be expected to be at background levels.
Minor	Changes in baseline soil resource conditions would be expected to be small in magnitude and limited in areal extent. Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area.[†] Increased erosion and sedimentation would be expected to be limited to the immediate vicinity[‡] of roadways, power lines, drill sites, and mine sites. Concentrations of uranium and arsenic in soil would be expected to be at or above regional background levels off site, but generally at or below applicable[§] remediation standards; exceedance of standards would be expected to be limited to the immediate vicinity of mine sites.
Moderate	Changes in baseline soil resource conditions would be expected to be moderate in magnitude and areal extent. Anticipated soil disturbance in each proposed withdrawal parcel would be between 1% and 2% of the parcel area. Increased erosion and sedimentation might extend beyond the immediate vicinity of roadways, power lines, drill sites, and mine sites. Rates of erosion might be greater than that described for minor impact because of the presence of steep topography or sensitive soils. Concentrations of uranium and arsenic in soil might be generally at or above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites.

Table 4.5-1. Magnitude and Degrees of Effects on Soil Resources (Continued)

Attribute of Effect	Description Relative to Soil Resources
Major	Changes in baseline soil resource conditions would be expected to be large in magnitude and distributed over a wide area. Anticipated soil disturbance in each proposed withdrawal parcel would be greater than 2% of the parcel area. Increased erosion and sedimentation might extend well beyond the immediate vicinity[e] of roadways, power lines, drill sites, and mine sites; impacts might reach adjacent basins. Concentrations of uranium and arsenic in soil might be generally above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites.

* Applicable when no mining is anticipated to occur in the RFD scenario.

† Numeric thresholds for disturbance define the magnitude of the impact and do not imply a level of significance for disturbance-related impacts. Refer to direct and indirect impact analysis for discussion regarding magnitude of soil disturbance.

‡ Increased erosion could vary from a few feet to several hundred feet from disturbed areas. Based on results of Otton et al. (2010), concentrations of uranium and arsenic in soil typically approach background levels or remedial standards at a distance of about 500 feet or less from mine sites, except in the case of mines located within canyons or large drainages (i.e., Hack Canyon Mines) where concentrations of uranium and arsenic above SRLs and/or background levels were detected up to about 0.5 mile from the mine sites.

§ The non-residential SRL for uranium is 200 and 10 ppm for arsenic. AAC R18-7-203 permits operators to remediate soils to either SRLs or site-specific background levels. Site-specific background soil conditions in the vicinity of mineralized breccia pipes may exceed arsenic concentrations of 10 ppm.

¶ By definition, increased erosion might range from about 0.5 mile to several miles from disturbed areas, and distribution of uranium and arsenic to levels above SRLs or background might occur from 0.5 mile to several miles from mine sites.

[e] By definition, increased erosion might range from about 0.5 mile to several miles from disturbed areas, and distribution of uranium and arsenic to levels above SRLs or background might occur from 0.5 mile to several miles from mine sites.

Table 4.5.2. Duration Definition of Effects on Soil Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

Table 4.5-3 is a summary of the outcomes for evaluation of soil impact criteria across all three proposed withdrawal parcels and alternatives under consideration.

Table 4.5-3. Summary of Potential Direct and Indirect Impacts to Soil Resources

	Soil Disturbance	Soil Erosion	Soil Contamination
Alternative A			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	Minor	Minor to Moderate	Minor to Moderate
South Parcel	Minor	Minor to Moderate	Minor to Moderate
Alternative B			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	None	None	None
South Parcel	Minor	Minor	Minor
Alternative C			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	Minor	Minor	Minor
South Parcel	Minor	Minor	Minor
Alternative D			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	Minor	Minor to Moderate	Minor
South Parcel	Minor	Minor to Moderate	Minor to Moderate

Assumptions for Impact Analysis

Assumed activities described in the RFD scenarios related to the proposed withdrawal that could result in soil disturbance and/or accelerated erosion are as follows:

- Establishment of new exploration drill sites
- Development of new mine facilities
- Construction of new roads
- Installation of new power lines

Assumed activities described in the RFD scenarios that are related to the proposed withdrawal and could impact soil chemical quality through potential distribution of contaminants include the following:

- Operation of mines under approved plans of operation,
- Establishment of new exploration drill sites, and
- Development of new mine facilities.

Assumed past, present, and future activities and conditions that might contribute to cumulative impacts on soil resources are as follows:

- Fuels management and noxious weed removal programs;
- Past wildfires and fire suppression, past cattle grazing, and past drought conditions;
- Recreation and tourism, including use, development, and maintenance of campgrounds (South Parcel) and trails;
- Installation of roads and utilities (water and power lines);
- Development on private lands, including development in response to population growth;
- Other drilling (for oil, gas, and/or water), fluid mineral leasing programs, other mining activities (copper mines, small-scale stone quarries, or sand and gravel operations); and past uranium exploration projects, as summarized in the RFD scenarios;
- Past uranium mining activities at the Hack Canyon, Hack 1, Hack 2, Hack 3, Hermit, and Pigeon mines in the North Parcel and the Orphan Mine near the South Parcel;
- Uranium mines currently operating under approved plans of operation, which include the Kanab North, Pinenut, and Arizona 1 mines in the North Parcel and Canyon Mine in the South Parcel.

The most significant limitation to this impact analysis is that the locations of new mines expected to be developed, as described in the RFD scenarios, are not known. Some impacts and potential risks are site-specific; thus, generalization of potential impacts was required through adoption of the following assumptions:

- Although the potential for accelerated soil loss varies somewhat, depending on the type of mining-related ground disturbance, the net impacts do not vary enough to change the assigned impact category.
- Data regarding the favorability of soils to be reclaimed were not available; it was assumed that soil productivity after reclamation would not be impaired enough to change the assigned impact category.
- Data are not available to assess site-specific conditions that may enhance soil contamination impacts; therefore, potential for soil contamination is assumed to be the same for all mines.

- Fugitive dust is identified as the primary mechanism for potential off-site distribution of contaminants from mine sites. The composition of the particulate matter in fugitive dust would be expected to vary based on many factors that cannot be reasonably estimated. Thus, uranium and arsenic concentrations detected in soil samples collected around previous mine sites are assumed to represent a proxy for overall contamination impacts from fugitive dust. This approach is supported by the findings of Otton et al 2010, which concluded that uranium and arsenic "were consistently the most abundant trace elements of concern at mined sites." In addition, data for other constituents, particularly background values in the area, are sparse; thus, it is not feasible to incorporate them into the analysis.
- Data on past and current conditions regarding distribution of mine-related constituents in soil and sediment were obtained primarily from a study conducted by the USGS in fall 2009 (Otton et al. 2010). These data are assumed to be a reasonable representation of past and present conditions and reasonably foreseeable future conditions in the proposed withdrawal area. Uranium and arsenic results from this study are used to represent overall impacts from uranium-mining related contamination of soil and sediment.

4.5.2 Compliance with Environmental Regulations and Permitting

For operations on BLM-managed lands, BLM's regulations require operators to implement appropriate design features and comply with all applicable state and Federal laws to prevent unnecessary or undue degradation. For operations on Forest Service lands, regulations require that all operations, where feasible, shall be conducted to minimize all adverse environmental impacts on surface resources, including compliance with all federal and state water quality standards. It should be emphasized that detailed, site-specific environmental analysis would be required for any new mines in the proposed withdrawal area and that the data necessary to assess the potential impacts on a case by case basis would be obtained and evaluated at that time. As described in plans of operation for mine sites in the North Parcel, including the Arizona 1, Hermit, Kanab North, Pinenut, and EZ-1, EZ-2, and What mine sites, measures are implemented to minimize land disturbances and conserve soil resources (Energy Fuels Nuclear, Inc. 1984, 1986, 1987, 1988a; JBR Environmental Consultants 2010). In addition, aquifer protection and air quality control permits are required by ADEQ (2009d, 2009e). Approved mine sites are routinely inspected for compliance with their approved plans of operation and other permits. Examples of stipulations or required mitigation measures in approved plans of operations include the following:

- Areas of disturbance are as small as is practicable, with surface facilities, stockpile, and disposal areas clustered together.
- During construction and excavation, existing vegetation is left in place to the extent practicable, and native soils are stockpiled for later use in site reclamation.
- Natural drainage features are maintained to the extent possible, and grading is designed to maintain natural drainage as much as is practicable. Access roads are graded to follow existing topography.
- Vehicle speed is limited to 25 mph on unpaved roads, and dust suppression, typically light water spraying, is used to control fugitive dust. These requirements are typically established through an ADEQ Air Quality Control permit.
- Procedures for recovery and cleanup of materials spilled during transport are established in emergency response plans, which may be required under APP permits or may be included in plans of operation.

- Lined below-grade evaporation ponds are used to contain on-site runoff and mine drainage pumped from the collection sump at the bottom of the mine. These ponds are regulated by ADEQ's APP, which generally requires BADCT to minimize leakage potential. APP permits include requirements to maintain proper fluid levels in the pond at all times and a contingency to ensure this occurs. The evaporation pond is sized to retain stormwater runoff from a 100-year, 24-hour flood event.
- Perimeter berms and diversion channels are engineered and constructed to withstand a 500-year, 24-hour flood event outside the mine site perimeter. These structures are required pursuant to plans of operation and APP permits. The perimeter berm is intended to contain mining-generated materials and soil within the site by preventing run-on from entering the site and runoff from leaving the site. Engineering designs for these berms are based on site-specific hydrologic models. Although failure or overtopping of the berms is not reasonably foreseeable, ADEQ would require remedial action under the APP in the unlikely event that waste rock, ore, and/or material from the evaporation pond were released from the site.
- Engineered ore pads are constructed to contain stockpiled waste rock and ore and prevent leaching of excavated material to native surface soil during rainfall events. Waste rock/ore stockpiles are regulated by ADEQ APP requirements, which include BADCT. Dust suppression procedures are used to control fugitive dust from stockpiles (covering or stabilization).
- Each mine operator is required to submit an interim management plan for approval with the site plan of operations. These plans establish actions required during periods of temporary or seasonal closure to avoid causing unnecessary or undue degradation. Such actions include measures to stabilize excavations and workings; isolate or control toxic or deleterious materials, store or remove project equipment, supplies, and structures; and maintain the site in a safe, clean condition. In addition, the plan must address monitoring that will be conducted during the period of non-operation; the amount and type of monitoring is determined based on several factors, such as the type of operation and risk of environmental impacts. The regulations also require the operator to maintain an adequate financial guarantee and include provisions for agency review of the interim management status of a project that has been inactive for 5 years to determine whether the project should terminate its plan of operations and begin final closure and reclamation.

At the conclusion of mining activities, areas of operation must be fully reclaimed to state and federal requirements. General reclamation measures are described in Appendix B. The plan of operations for individual mines includes a reclamation plan, and the agency having jurisdiction monitors reclamation activities for compliance prior to release of the reclamation bond (see Appendix B). As described in *Plan of Operations/Reclamation Plan and Reclamation Bond Estimate for the EZ-1, EZ-2, and What Breccia Pipe Mine*, measures would be implemented to provide for complete reclamation of disturbed areas after completion of mining activities (JBR Environmental Consultants 2010). Reclamation activities are designed to allow post-mining land uses that are consistent with the surface managing agency's applicable land use plan to return lands to a level of productivity consistent with pre-mining levels.

The following reclamation activities have been typically required under plans of operation for former mine sites:

- All surface plant equipment, buildings, materials, supplies, and mobile equipment are removed.
- Sediments accumulated in evaporation ponds are excavated and removed from the site or buried in the mine workings if concentrations of metals, radon, and uranium are detected at levels above background.

- Areas of operation are re-graded to the approximate original topographic contours, and native soil or natural sediments are placed to a uniform thickness. Disturbed areas are seeded with an approved seed mixture, and the disturbed soils are ripped or disked to reduce compaction impacts.
- Areas prone to erosion are armored with erosion-resistant aggregate.
- Diversion channels would remain in place to divert surface run-off around re-seeded areas and are re-contoured after vegetation has been adequately established.
- Access roads are fully reclaimed unless agencies request they be left in place as part of the regional road system. Roads having no further use are re-contoured to pre-disturbance topography, ripped to a depth of 18 to 24 inches to loosen compacted material, and seeded.
- Reclamation efforts include an extensive radiometric survey of the areas of operation. Any material encountered that exceeds acceptable radiation standard for long-term exposure (10 mrem/yr) is removed from the site or buried in the mine workings before the area is graded and covered with soil. At closure, soils are required to meet ADEQ SRLs (Background Remediation Standards).
- Reclaimed sites are monitored on a regular basis after closure to evaluate the effectiveness of the reclamation actions and to maintain the designed features against erosion.

4.5.3 Impacts of Alternative A: No Action (No Withdrawal)

In Alternative A, mineral exploration and development would proceed under existing law, regulation, and policy. The overall impact on soil resources would be expected to range from minor to moderate in all three proposed withdrawal parcels (see Table 4.5-3). The largest amount of mining development in each of the three parcels is foreseen (30 mines), resulting in larger estimated areas of land surface disturbance (1,364 acres) and the greatest potential for distribution of contaminants in soil at multiple locations during mining operations than under other alternatives. Soil impacts would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

Disturbance of soils associated with development of new drill sites,[17] mine facilities, roadways, and power lines to accommodate mining activities in the proposed withdrawal parcels would be expected to result in direct impacts on soil productivity; areas in use during mining operations would effectively support little or no vegetation. Mine site perimeter berms are part of this disturbance. The anticipated area of disturbance in each proposed withdrawal parcel would be less than 0.2% of the respective total parcel areas, or 945 acres out of about 550,000 acres for the North Parcel, 107 acres out of about 134,000 acres for the East Parcel, and 312 acres out of about 322,000 acres for the South Parcel. Even if the entire anticipated disturbance occurred in one sub-basin or area, which is not likely based on locations of past uranium mines, the impact to overall soil productivity and watershed function would be small because the level of disturbance represents a very small fraction of the respective parcel areas. In addition, the magnitude of the direct impact would be somewhat less than the total anticipated disturbed area because not all the disturbance would occur at once: some areas would be reclaimed prior to disturbance related to other sites. Thus, disturbance impacts would be minor because of the small amount of relative disturbance and would generally be of short duration, about 5 years, which is the average lifespan of a mine from

[17]According to the RFD scenarios (see Appendix B), disturbance for exploration drilling does not include disturbance related to temporary road construction because sites for breccia pipe exploration are typically reached by overland travel.

development through reclamation activities. However, the duration of direct impacts could be different if the any of the uncertainty factors identified in the RFD scenario are encountered; for example, if the ore body is larger or smaller than estimated, or if the operator decides to initiate a temporary closure and conduct operations under the interim management plan in the approved plan of operations. In this case, the duration of the impact could be longer or shorter than the period for these activities estimated in the RFD scenarios.

Indirect disturbance impacts are those that may remain after reclamation. If reclamation efforts are not completely effective, disturbed areas may suffer some reduction in productivity after operations cease because of compaction and other changes in soil physical properties, such as a loss of organic matter and/or developed horizons. However, based on reclamation practices under existing regulations and results of reclamation efforts at former uranium mines in the North Parcel, such as the Hermit, Pigeon, and Hack Canyon mines (for example, see Energy Fuels Nuclear, Inc. 1988a), it is expected that reclamation efforts would be generally effective in returning the soil to levels of productivity that are similar to pre-disturbance conditions. Thus, indirect impacts would be expected to be minor but might be of a long duration (more than 5 years) because it may take several growing seasons or more to re-establish full productivity.

INCREASED SOIL EROSION

The degree to which soil resources may be susceptible to increased rates of erosion from water and wind action depends on geomorphic setting, topography, climate, and the physical, chemical, and mechanical properties of the dominant soil types encountered at each site. NRCS soil survey information for BLM-managed lands described in Section 3.5 indicate that the majority of soil types identified in the North and East parcels are moderately to severely susceptible to off-road erosion and generally exhibit a moderate hazard of erosion from unsurfaced roads, which do not include overland routes to reach drill sites. Wind erodibility in the North Parcel is reported by the NRCS to be generally low to moderate (WEG[18] of 8 to 5), and wind erodibility in the East Parcel is generally moderate to severe (WEG of 4 to 1). TES data described in Section 3.5 for the South Parcel indicate that the off-road erosion hazard is slight to moderate for most soils, and the suitability of soils for unsurfaced roads (related to erosion risk) is generally severely limited. Wind erodibility for the South Parcel has not been established but is expected to be less than the North and East parcels because of the relatively dense vegetative cover, except in areas subject to severe wildfire damage. In general, soil erosion hazards are greater where slopes are steep or depth to bedrock is shallow, which occurs in several areas of each proposed withdrawal parcel. Additional information regarding the distribution of soil erosion hazard ratings is provided in Section 3.5. For the purposes of this impact assessment, specific areas identified to be potentially sensitive to erosion hazards include the following:

- **North Parcel.** Kanab Creek and major tributary canyons, the north-central portion of the parcel, and areas adjacent to the Kaibab National Forest in the northeastern portion of the parcel.
- **East Parcel.** Tributary canyons adjacent to the Colorado River, along with the western and north-central portions of the parcel.
- **South Parcel.** The Coconino Rim, Red Butte area, and various drainage channels tributary to the Little Colorado River and Cataract Creek identified as exhibiting a high risk of erosion in the TES.

Accelerated soil loss associated with exposure of soil particles to water and wind erosion could result from surface disturbance activities such as excavation, grading, and removal of vegetation. Additional soil erosion could also occur from increased stormwater runoff resulting from a reduction in infiltration capacity associated with soil compaction or from alteration of drainage patterns related to construction of

[18] See Section 3.5 for description of WEGs.

roads and mine site perimeter berms. These direct soil loss impacts could occur at work sites during construction and operation activities.

At mine sites, soil is generally not lost from water action because containment berms form site boundaries. The probability of a flood breaching a properly designed, constructed, and maintained perimeter berm over 20 years is about 4%. Some soil might be lost from the backslope of the berms (side facing away from the mine) because of water erosion; however, this condition can be controlled through proper berm maintenance. Soil loss from wind erosion is likely at mine sites because of continual exposure of the soil and sources of dust, such as vehicle travel, within the mine site; this source of erosion may be controlled through an aggressive dust control program and stabilizing exposed surfaces susceptible to wind erosion where feasible.

Runoff-related increases in soil erosion from roads, drill sites, and power lines might be larger than those associated with mine sites because containment berms are absent. However, disturbance along power lines and drill sites is temporary and limited in extent. Once construction of the power line or drill site is complete, additional disturbance would occur occasionally for power lines, and only if maintenance is required, and additional disturbance would not occur for drill sites once drilling is complete. The extent of disturbances for power lines is limited to that required for pole placement, and the extent of a typical drill site is only about 1.1 acres, according to the RFD scenarios (temporary roads not typically required). In addition, drill sites are required to be reclaimed following completion of the exploration project. Construction and use of new roadways present a larger soil erosion potential than other activities considered. The number of haul trips may slightly increase erosion risks because repeated use of roads may result in additional compaction and/or displacement of soil particles; development of ruts that might create pathways for runoff, thus resulting in potentially greater soil loss; and extensively used roads could require increased maintenance, leading to additional compaction and displacement. However, these impacts would be expected to be effectively controlled through standard BMPs, and after mine closure, these roads would be reclaimed. Increased loss of soil from wind activity is possible at all disturbed areas; however, the potential volume of soil that could be lost from this process is relatively small because dust management practices would be expected to provide effective control. Overall, direct impacts to soil from erosion would be expected to be minor throughout most of the proposed withdrawal area under existing regulations and would be expected to be of short duration (4 to 5 years).

Land surface disturbance might cause increased erosion of natural drainage channels and/or sedimentation in natural channels, sinkholes, or humanmade retention basins (i.e., “tanks”). Such indirect impacts might occur off-site and even after reclamation is complete. However, these impacts would be expected to be largely limited to areas downgradient of and/or downwind from and in relative close proximity to drill sites, mine sites, power lines, and haul roads. Although eroded soil from mine sites would be contained by perimeter berms, alteration of drainage patterns around mine sites might result in increased downstream erosion. Moderate indirect impacts are possible where mine sites are located within or adjacent to large natural drainage channels and/or canyons because eroded soil has the potential to move farther away from the mine site during floods, periods of stream flow, or where wind can transport soils into canyons. In addition, soils on steep slopes or otherwise erosion-sensitive soils (thin, fine-grained, and/or poorly cohesive) have the potential to experience higher rates of erosion than other soils. All three proposed withdrawal parcels have some areas of steep topography or canyons and areas of sensitive soils. Although increased erosion impacts would be expected to be generally minor under Alternative A, moderate impacts might occur if specific roads, exploration sites, or mine sites are located in these steeper areas.

SOIL CONTAMINATION

Materials extracted from breccia pipes and brought to the surface by mining processes could directly impact surficial soils at the mine sites during mining operations by introducing contaminants. These direct impacts include potential mixing of ore and/or waste rock with native surface soils; and leaching and subsequent infiltration of heavy metals and other toxic substances into the soil. Contamination of soils from exploration drilling is anticipated to be minimal, based on results of sediment sampling at the Kanab South Pipe exploration site (Otton et al. 2010) and because the disturbed area is small and the only potential source of contamination is drill cuttings, which would constitute a relatively small volume of material. Impacts at mine sites may exceed the ADEQ SRL of 200 ppm for uranium and 10 ppm for arsenic (ADEQ 2007); however, such a high magnitude of impact is expected to be temporary because of removal and/or covering of contaminated soils during reclamation activities. Thus, potential direct impacts on soil chemical quality would be expected to be minor; duration of the impact is expected to be about 5 years, which is the average lifespan of a mine from development through reclamation. However, the duration of direct impacts could be different if any of the uncertainty factors identified in the RFD scenarios are encountered; for example, if the ore body is larger or smaller than estimated, or the operator decides to initiate a temporary closure and conduct operations under the interim management plan in the approved plan of operations.

Indirect impacts might result from exposed waste rock and ore stockpiles that are susceptible to wind erosion; contaminants might be dispersed by wind and deposited off-site. Fugitive dust is the primary mechanism of contaminant dispersal during mining operations because stormwater run-on and run-off is controlled by mine site perimeter berms. Although levels of uranium and arsenic in soil or sediment might be above background levels and/or non-residential SRLs for uranium (200 ppm) and arsenic (10 ppm), concentrations would generally be expected to approach SRLs or background levels within a few hundred feet from mine sites (approximately 500 feet).[19] This conclusion is supported by data collected by Otton et al. (2010) at the Kanab North Mine, where wind dispersion of material has occurred from exposed soils, mine-waste, and ore stock piles when the mine was active and from such materials remaining on-site over the approximately 20-year period that the mine has been under interim management. In 22 soil samples collected within 420 feet from the unreclaimed Kanab North Mine, the uranium concentration in soil ranged from 2.9 to 80.2 ppm and averaged 27.8 ppm, and the arsenic concentration ranged from 3 to 27 ppm and averaged 12 ppm. The two samples collected farthest from the Kanab North site, at 300 and 420 feet away, contained 10.3 and 6.9 ppm of uranium and 9 and 8 ppm of arsenic, respectively. Concentrations of uranium and arsenic in the vicinity of other sites studies are higher (Pigeon Mine) and lower than these results (Hermit Mine). This could be because background conditions are different at these sites, or the magnitude of the impact is different because of the intensity of mining activities. Impact to soils from distribution of mine-related constituents would be expected to be generally minor because exceedance of standards would be expected to be limited to the immediate vicinity of mine sites. After site reclamation, distribution of additional contaminants to off-site areas would be expected to be negligible. The magnitude of any off-site impacts (in undisturbed areas) would be expected to occur within close proximity to the mine sites; these impacts would be expected to be long term (greater than 5 years).

Impacts to soil chemical quality may remain at mine sites after closure, depending on the effectiveness of reclamation efforts and the physiographic/topographic setting of the site (i.e., potentially higher rates of erosion in areas of steep terrain or within stream channels). The chemical quality of soil within disturbed areas would represent materials used for reclamation and thus would be expected to generally meet current remedial standards (e.g., SRLs). Data collected by the USGS in 2009 (Otton et al. 2010) at the reclaimed Pigeon and Hermit mines support this conclusion; at the Pigeon Mine, only localized areas of soil were detected containing higher levels of trace elements than elsewhere on-site. These higher levels of mine-related constituents were likely related to the presence of mine-waste materials remaining on-site,

[19]The SRL for uranium was not generally found to be exceeded on- or off-site at reclaimed mines and off-site at mines operating under interim management (Otton et al. 2010). The SRL for arsenic was found to be exceeded both on- and off-site in many locations. However, this standard is based on estimated background for the state of Arizona; background conditions in the vicinity of mineralized breccia pipes may exceed 10 ppm. AAC R18-7-203 permits operators to remediate soils to either SRLs or site-specific background levels.

possibly uncovered by erosion. These residual impacts are an example of reclamation efforts that were not completely successful; such impacts are minor because of their limited extent and could be mitigated through more aggressive remedial action and monitoring after closure. Impacts to soil from mine-related contaminants on-site after reclamation would be expected to be generally minor in terms of magnitude and extent; duration of the impact would be expected to be long term (greater than 5 years). Because undisturbed areas are not typically reclaimed, levels of mine-related constituents after reclamation would be expected to be about the same as at the end of the operational or interim management period.

As with soil erosion impacts, mines located within or adjacent to large drainage channels, canyons, or steep slopes present an additional risk of contaminant dispersal from wind and floods; the site-specific risk is evaluated during review of individual mine plans of operation. The impact associated with such mines might be moderate because the extent of dispersal and accumulation of mine-related constituents in soil and sediment to levels exceeding SRLs or background levels may extend beyond the immediate vicinity of the mine sites. Such impacts are possible from actions described in the RFD scenarios since all three proposed withdrawal parcels have some areas with canyons, large drainages, or steep slopes. Examples of previous and existing mines where such impacts may have occurred include the Kanab North Mine and the Hack Canyon mines (Otton et al. 2010). In the case of the unreclaimed Kanab North Mine, some contaminant dispersal beyond 420 feet may have occurred because of the close proximity of the mine to the canyon of Kanab Creek. Although this impact is conceivable, no data were collected to confirm this possibility. However, the highest uranium concentration identified outside the Kanab North Mine perimeter (80.2 ppm) was detected in a soil sample collected immediately adjacent to the edge of the canyon of Kanab Creek east from the mine site (Otton et al. 2010:Figure 14). Levels of dispersed contaminants accumulated in off-site soils would still likely be below the SRL for uranium or a few ppm above the SRL for arsenic because the maximum uranium concentration measured was 80.2 ppm and the maximum arsenic concentration measured was 27 ppm. An example of an increased risk of constituent dispersal from flooding in canyons and drainage channels is provided by the reclaimed Hack Canyon Mine complex, which was located on the floor of a large canyon. Flood events reported to have occurred during mining operations and/or floods that were inferred to have eroded reclaimed areas and displaced covered mine-waste materials are thought to have dispersed contaminants some distance from the Hack Canyon Mine sites (Otton et al. 2010). Data collected by Carver (1999) in September 1998 and May 1999 found that mean concentrations of trace elements in sediment samples collected upstream from the mines were equal to those collected downstream from the mines; this result was confirmed from samples collected in the fall 2009 by the USGS (Otton et al. 2010), as they found that concentrations of most trace elements in sediment collected within about 2 to 3 miles downstream of the mines were about the same as those collected upstream. It should be noted that the Hack Canyon Mine complex was not protected by perimeter berms because of space constraints on the canyon floor. Thus, although mines located within major drainage channels might result in dispersion of contaminants that is moderate in extent, dispersion of mine-generated materials at the Hack Canyon Mine complex represents an atypical scenario because few mines are likely to be located in canyons or lack perimeters berms based on past locations of mines.

Cumulative Impacts

Cumulative impacts to soils are related to increases in the total amount of disturbed acreage, overlapping erosion impacts from exploration sites, roadways, power lines, and approved mines in close proximity to one another or to other activities or conditions occurring in the parcels, or increases in the total number of contaminated sites and overlapping contamination from mines in close proximity. All the activities or conditions listed in the analysis assumptions (see Section 4.5.1) could result in ground disturbance and subsequent increased rates of erosion. Cumulative contamination impacts, if present, are likely to only result from past uranium mining and future non-uranium mining activities. Duration of cumulative impacts would be expected to be long term (more than 5 years).

The spatial scale of cumulative impact analysis is different from that considered for direct and indirect impacts in that the impacts may not necessarily be related solely to the locations of uranium mining activities. Impacts from all past and present activities or conditions and non-uranium mining activities or conditions that are reasonably foreseeable are difficult to quantify. Thus, because of these different factors, descriptions established in Table 4.5-1 are not appropriate for discussion of cumulative impacts. Instead, cumulative impacts are analyzed through comparison of the relative magnitude, in qualitative terms, of impacts resulting from reasonably foreseeable uranium mining activities (i.e., “RFD-scenario activities”) and impacts resulting from other past, present, or reasonable foreseeable activities and conditions (i.e., “other activities”) listed in Section 4.5.1. Overall, disturbance and increased erosion impacts resulting from RFD-scenario activities would be very small, compared with such impacts from other activities; however, distribution of contaminants in soil and sediment from RFD-scenario impacts would be expected to be similar or larger in areal extent to impacts from other activities.

Thousands of acres in the proposed withdrawal area have been disturbed because of activities and conditions other than those outlined in the RFD scenarios; such disturbance is anticipated to continue into the future at a lower rate than in the past. These disturbances have impacted large portions of the proposed withdrawal area. Activities and conditions in the region associated with the largest and most aerially extensive impacts related to disturbance and increased erosion are previous cattle grazing, wildfires, and droughts that have occurred over the past 150 years. The loss of vegetation from these disturbances has resulted in increased erosion throughout the area and, in some cases, allowed the introduction of invasive species of grasses and shrubs, which has increased the risk of wildfires. Recent wildfires in the area include the X-Fire in the South Parcel (2,000 acres southeast from Tusayan in 2008) and the Warm Fire (39,100 acres west of the East Parcel in 2006) (Forest Service 2009h). The Warm Fire did not occur within the proposed withdrawal area; however, increased erosion from this large wildfire might have resulted in sedimentation along the western margin of the East Parcel. Recent drought conditions that occurred from 1998 to 2004 have resulted in increased risk of wildfire and loss of vegetation in the parcels, such as widespread mortality of pinyon-juniper and ponderosa trees. Future wildfires and droughts are foreseeable in the region; however, their effects and timing cannot be reasonably estimated. Additional impact from cattle grazing would be expected to be relatively small, compared with past cattle-grazing activities as a result of current permit requirements, modern management techniques, and reduced stocking rates. Past, current, and foreseeable future activities resulting in somewhat smaller disturbance and erosion impacts than cattle grazing, wildfire, and drought include fuels reduction and noxious weed removal programs, fire suppression (construction of temporary access roads), mine and quarry development,[20] exploration and water well drilling, and development and use of roads and trails. Although the individual impact from these activities may be relatively small, the cumulative impact would be expected to be large. Anticipated population growth in the region, primarily in southern Utah, might accelerate disturbance by way of increased development in general on private property within and adjacent to the withdrawal area and increased development and use of recreation areas (such as trails and campgrounds). Because there is relatively more private property within and adjacent to the North Parcel that is close to significant population centers, such as Fredonia and Kanab, the cumulative impacts from development on private lands are anticipated to be greater than for the other two parcels.

Disturbance and increased soil loss related to past, present, and future, activities or conditions other than those outlined in the RFD scenarios are potentially several orders of magnitude larger in intensity and areal extent than impacts from activities outlined in the RFD scenarios. Thus, addition of uranium mining related activities in the RFD scenarios would result in a very small contribution to the overall level of disturbance and soil loss in the proposed withdrawal area. In addition, erosion control measures would be

[20] Includes the following numbers of separate sand and gravel or quarry operations: eight in the North Parcel, two in the East Parcel, and one in the South Parcel.

expected to be largely effective for all activities approved and reviewed by federal and state agencies with jurisdiction in the area.

Under Alternative A, the number of uranium mines that are reasonably foreseeable would be equal to or greater than past and current uranium and non-uranium mining activities. For example, in the North Parcel, there could be 18 new uranium mines, compared with eight reclaimed/existing uranium mines. Thus, the addition of potential RFD-scenario impacts to impacts from previous uranium and non-uranium mines could result in a large increase in the total areal extent of impacted soils and number of sites where contamination might occur. However, it should be recognized that the type of constituents that may contaminate soils in the vicinity of non-uranium mines and/or quarries may be different than those associated with uranium mines. Thus, because no previous uranium mining has occurred in the East and South parcels, it is unlikely that cumulative impacts related to contamination would occur in these parcels.

Increases in the concentration of contaminants in soil to levels above those projected under direct and indirect impacts might result from overlapping areas of contamination by transport and deposition of materials away from mine sites. Transport of materials from sites by water would not be expected to occur for any mine operating under approved plans of operation because of the general requirement for perimeter berms surrounding the sites. Transport of materials away from reclaimed mine and exploration sites, including the Pigeon and Hermit mines, would not be expected to contribute to cumulative contamination-related impacts because the reclaimed soils at these sites have been stabilized and re-vegetated. Overlap of contamination impacts from dispersal and subsequent deposition of fine-grained materials by wind would also be unlikely because breccia pipes close enough to one another to have measurably overlapping dust plumes would typically be served by a single surface site, such as the EZ-1, EZ-2, and What pipes. Reclaimed mines and mines operating under approved plans of operation were surveyed by the USGS in 2009 (Otton et al. 2010), and sample results indicated that levels of contaminants in surface soils generally approach SRLs for uranium and arsenic within about 500 feet or less from the mines sites. An exception to this might occur in areas of steep topography or large drainage channels where sufficient energy may be available to move contaminants farther away from the sites by wind or water action (including water erosion of soils impacted by wind dispersion). This appears to have occurred at the reclaimed Hack Canyon Mine complex, where exceedance of the arsenic SRL and background levels were detected about 0.5 mile downstream of the mines (Otton et al. 2010). However, transport of materials by water for large distances also results in dilution of the mine-related constituents by incorporation of native fine-grained sediments into stream bed loads.

No cumulative impacts would be expected from the Orphan Mine near the South Parcel because it is located in an area that is directly tributary to the Colorado River, while streams in the South Parcel are tributary to either Cataract Creek or the Little Colorado River (see Figure 4.4-3). Erosion-related impacts would not be expected to extend far enough to have a cumulative impact downstream in the Colorado River. Similarly, potential contaminants transported away from the Orphan Mine or new mines by wind would not likely travel far enough to have a cumulative impact on concentrations of mine-related constituents in soil because the Orphan Mine is about 3.5 miles away from the South Parcel.

Unavoidable Adverse Impacts

Adverse impacts to soil resources that are inherent in the process of mine development and operation would be expected to be minimal under existing regulations. Such impacts include loss of soil from road construction and mine site development that would occur following surface disturbance from both water and wind action, soil compaction, and removal of vegetation. Loss of soil at mine sites during operations is minimal, given that site perimeters include substantial containment berms. Reclaimed mine sites would be expected to have rates of soil loss comparable to pre-disturbance conditions. Loss of soil from new roadways and power lines could be larger but are effectively controlled under existing regulations.

Impacts from soil compaction would also be expected to be reduced during reclamation by ripping or disking the disturbed soils to aid in revegetation. Some dispersal of uranium contamination by wind might be unavoidable at certain sites, but based on studies at reclaimed mines and mines operating under interim management the off-site impact would range from minor to moderate because concentrations of trace elements in surficial media would be expected to be at or below the SRL for uranium (200 ppm) and may meet applicable standards for arsenic, depending on determination of background conditions at each site. In disturbed areas, soils would be reclaimed to meet SRL standards.

4.5.4 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

The proposed withdrawal under Alternative B would prohibit the location of new mining claims and restrict exploration, development and mining operations to mining claims with valid existing rights. The overall impact on soil resources would be expected to range from none to moderate (see Table 4.5-3). The relative impact would be expected to be the smallest under Alternative B, compared with all other alternatives. The smallest amount of mining development (11 mines) in each of the three parcels is projected to occur under this alternative, resulting in the smallest estimated area of land surface disturbance (163 acres) and the smallest potential for distribution of contaminants in soil during mining operations than under other alternatives. There is no anticipated impact for the East Parcel because no mining would take place under this alternative. Soil impacts in the North and South parcels would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

The nature of potential soil disturbance impacts in the North and South parcels would be the same as described for Alternative A. However, the amount of soil disturbance that is anticipated under Alternative B is the smallest for all the alternatives; there would be no impact in the East Parcel. Nearly all of the disturbance would be in the North Parcel (163 acres, which is about 0.03% of the total area of the North Parcel). The soil anticipated disturbance in the South Parcel is only 1 acre (new power line), which represents a negligible impact.

INCREASED SOIL EROSION

The nature of potential impacts on soils resulting from accelerated erosion in the North and South parcels would be the same as described for Alternative A; however, the total amount of impacted area would be considerably smaller because of less ground disturbance. Alternative B proposes to withdraw all areas of steep topography, canyons, and areas of soils susceptible to erosion from new mine development. Such areas include Kanab Creek and major tributary canyons in the North Parcel, the north-central portion of the North Parcel, areas adjacent to the Kaibab National Forest in the northeastern part of the North Parcel, and the Coconino Rim and Red Butte areas in the South Parcel. Regardless of withdrawing these areas, some roads, exploration sites, and mines associated with valid existing rights that are anticipated to be developed in the North Parcel might be located adjacent to Kanab Creek or tributary canyons or in areas with sensitive soils; in addition, the Kanab North Mine is currently adjacent to Kanab Creek. Therefore, moderate impacts from increased soil erosion might occur in the North Parcel where roads, exploration sites, or mines are located in areas of steep topography or sensitive soils, but impacts would be expected to be minor in other areas. Soil erosion impacts in the South Parcel are anticipated to be minor because the only mining that would occur is associated with the existing Canyon Mine site, which is not located in an area of severe erosion risk. No impact would occur in the East Parcel.

SOIL CONTAMINATION

The nature of potential soil contamination impacts in the North and South parcels would the same as described for Alternative A; however, the total volume of potentially impacted soils would be considerably smaller in the North and South parcels for Alternative B. Although all areas of steep topography or canyons are withdrawn under this alternative, some mines with valid existing rights might still be located in these areas in the North Parcel. Therefore, moderate impacts from contaminant dispersal beyond the immediate vicinity of the mine sites might occur in the North Parcel, but impacts would be expected to be minor in most areas. Soil contamination impacts in the South Parcel are anticipated to be minor because the only mining that would occur is associated with the existing Canyon Mine site, which is not in an area of steep topography. No impact would occur in the East Parcel.

Cumulative Impacts

The nature of cumulative impacts under Alternative B related to soil disturbance and increased erosion would be the same as described for Alternative A; however, the magnitude of additional disturbance from RFD-scenario activities is considerably smaller than under Alternative A for all three proposed withdrawal parcels. The amount of surface disturbance for the North Parcel would be expected to be about 80% less than anticipated under Alternative A, based on relative acreages. The very small amount of anticipated disturbance for the South Parcel (1 acre) would result in negligible cumulative impact. No cumulative disturbance impact would occur in the East Parcel because no uranium mining-related disturbance is anticipated. Thus, cumulative disturbance impacts would be expected to be 100% less than anticipated under Alternative A.

The nature of cumulative contamination impacts to soil would be the same as described for Alternative A, except less anticipated mineral development means that the total potential area of impacted soil and number of potential impacted sites would be considerably smaller. For the North Parcel, seven new mines are anticipated to be developed, compared with 18 mines under Alternative A; adding these seven mines to the seven mines that are reclaimed and currently operating under approved plans of operation would be expected to result in a 100% increase in the total number of potentially impacted sites. No cumulative impacts related to soil contamination would be expected to occur in the East and South parcels because no previous or current uranium mining has occurred in these parcels.

Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative A.

4.5.5 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

On the approximately 650,000 acres withdrawn under Alternative C, new mines would be only permitted on mining claims that are determined to constitute valid existing rights. The remaining lands would be open to location of new mining claims and would not require a validity determination before development. Except for the North Parcel, new mines are anticipated to be located only in areas with no or minimal sensitivity to resource impacts (as described in Chapter 2) because of the configuration of the Alternative C boundary and the fact that all new mines assumed to be developed regardless of withdrawal are in the North Parcel (see Appendix B, Section B.8.3). The overall impact on soil resources would be expected to range from minor to moderate (see Table 4.5-3). The relative impact would be expected to be smaller than either Alternative A or D. Less mining development in each of the three parcels is projected to occur under Alternative C (18 mines), compared with Alternatives A or D (30 and 26 mines, respectively), resulting in smaller estimated areas of land surface disturbance (532 acres, compared with 1,364 and 951 acres, respectively) and a smaller potential for distribution of contaminants in soil during mining operations. Soil impacts would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

The nature of potential soil disturbance impacts would be the same as described for Alternative A; however, the amount of soil disturbance anticipated under Alternative C is smaller than the other alternatives, except for Alternative B. The relative percentage of anticipated disturbance in each proposed withdrawal parcel ranges from 0.04% in the East Parcel (54 of 134,454 acres) to 0.06% in the North Parcel (320 of 549,995 acres); the percentage for the South Parcel is 0.05% (158 of 322,096 acres). Thus, soil disturbance impacts are minor in all three withdrawal parcels.

INCREASED SOIL EROSION

The nature of potential impacts on soils resulting from accelerated erosion would be the same as described for Alternative A; however, the total amount of impacted area would be considerably smaller because of less ground disturbance. Alternative C proposes to withdraw most areas of steep topography, canyons, and areas of soils susceptible to erosion from new mine development. Such areas include Kanab Creek and major tributary canyons in the North Parcel, the north-central portion of the North Parcel, areas adjacent to tributary canyons to the Colorado River in the East Parcel, the majority of the western and north-central portions of the East Parcel, and the Coconino Rim and Red Butte in the South Parcel. Some mines anticipated to be developed in the North Parcel might be located adjacent to Kanab Creek or tributary canyons or areas of sensitive soils in the northeastern portion of the North Parcel; in addition, the Kanab North Mine is located adjacent to Kanab Creek. Therefore, minor to moderate impacts from increased soil erosion might occur in the North Parcel where roads, exploration sites, or mines are located in areas of steep topography or sensitive soils, but impacts would be minor in other areas. Although some steep areas along the southwestern margin of the East Parcel are not withdrawn under Alternative C, only one mine is anticipated to be developed; thus, it is unlikely that the mine would be located in this relatively small area. Therefore, no mines would be expected to be located in sensitive areas in either the East or South parcels because such areas would be largely withdrawn; therefore, only minor increases in erosion are anticipated in the East and South parcels.

SOIL CONTAMINATION

The nature of potential soil contamination impacts would be the same as described for Alternative A; however, the total volume of potentially impacted soils would be considerably smaller. Although most areas of steep topography or canyons are withdrawn under this alternative, some mines could be located in these areas in the North Parcel. Therefore, moderate impacts from contaminant dispersal beyond the immediate vicinity of the mine sites might occur in the North Parcel, where mines are located in or immediately adjacent to canyons or other steep areas, but impacts would be expected to be minor in other areas. No mines would be expected to be located in canyon or steep areas in either the East or South parcels because such areas would be largely withdrawn; therefore, only minor contamination impacts are anticipated in the East and South parcels.

Cumulative Impacts

The nature of cumulative impacts under Alternative C related to soil disturbance and increased erosion would be the same as described for Alternative A; however, the magnitude of additional disturbance from RFD-scenario activities based on relative acreages would be expected to be about 70% less for the North Parcel and about 50% for the South and East parcels.

The nature of cumulative contamination impacts to soil would be the same as described for Alternative A, except less anticipated mineral development means that the total potential area of impacted soil and number of potential impacted sites would be somewhat smaller. For the North Parcel, 10 new mines are anticipated to be developed, compared with 18 mines under Alternative A; adding these 10 mines to the eight mines that are reclaimed and currently operating under approved plans of operation would be expected to result in about a 125% increase in the total number of potentially impacted sites. No cumulative impacts related to soil contamination would be expected to occur in the East and South parcels because no previous or current uranium mining has occurred in these parcels.

Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative A.

4.5.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

On the approximately 300,000 acres withdrawn under Alternative D, new mines would be only permitted on mining claims that are determined to constitute valid existing rights. The remaining lands would be open to location of new mining claims, and would not require a validity determination before development. Except for the North Parcel, new mines would only be located in all but the most resource-sensitive areas (as described in Chapter 2) because of the configuration of the Alternative D boundary and the fact that all new mines assumed to be developed regardless of withdrawal are in the North Parcel (see Appendix B, Section B.8.4). The overall impact on soil resources would be expected to be minor in all three proposed withdrawal parcels (see Table 4.5-3). The relative impact on soil resources would be expected to be smaller than under Alternative A but possibly greater than under the other alternatives. Up to 26 mines are projected to occur under this alternative, resulting in a larger estimated area of land surface disturbance (951 acres, compared with 532 acres for Alternative C) and greater potential for distribution of contaminants in soil during mining operations than under the other alternatives, except for Alternative A. Soil impacts would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

The nature of potential soil disturbance impacts would be the same as described for Alternative A. However, the amount of soil disturbance that is anticipated under Alternative D would be larger than under Alternatives B or C and somewhat smaller than under Alternative A. The relative percentage of anticipated disturbance in each proposed withdrawal parcel ranges from 0.04% in the East Parcel (54 of 134,454 acres) to 0.12% in the North Parcel (668 of 549,995 acres); the percentage for the South Parcel is 0.06% (209 of 322,096 acres). Thus, soil disturbance impacts are minor in all three withdrawal parcels.

INCREASED SOIL EROSION

The nature of potential impacts on soils resulting from accelerated erosion would be the same as described for Alternative A; however, the total amount of impacted area would be somewhat smaller under Alternative D because of less ground disturbance. Alternative D proposes to withdraw most areas of steep topography and canyons and areas of soils susceptible to erosion from new mine development. Such areas include Kanab Creek and major tributary canyons in the North Parcel, areas adjacent to tributary canyons to the Colorado River in the East Parcel, the majority of the western portion of the East Parcel, and the Coconino Rim in the South Parcel. Some mines anticipated to be developed in the North Parcel might be located adjacent to Kanab Creek or tributary canyons or areas of sensitive soils in the northeastern and north-central portions of the North Parcel; in addition, the Kanab North Mine is located adjacent to Kanab Creek. Similarly, some mines anticipated to be developed in the East Parcel might be located in the north-central portion of the parcel where the soils are susceptible to wind erosion. Also, compared with the proposed withdrawal under Alternative C, more areas of steep topography, such as the Red Butte area and various drainage channels identified with a high erosion risk, are open to mineral development in the South Parcel. Given this condition and the larger number of mines foreseen under Alternative D in the South Parcel (five), mines might be located in one of these areas. Therefore, minor to moderate impacts from increased soil erosion might occur in all three proposed withdrawal parcels, where roads, exploration sites, or mines are located in areas of steep topography or sensitive soils. Increased soil erosion generally would be expected to be minor at most locations, especially in the East and South parcels, because a relatively small proportion of each parcel area not withdrawn includes canyons or steep topography.

SOIL CONTAMINATION

The nature of potential soil contamination impacts would be the same as described for Alternative A; however, the total volume of potentially impacted soils would be somewhat smaller. Although most areas of steep topography and canyons are withdrawn under this alternative, some mines could be located in the North Parcel either in or immediately adjacent to canyons or other steep areas. Therefore, moderate impacts from contaminant dispersal beyond the immediate vicinity of the mine sites might occur in the North Parcel where mines are located in or immediately adjacent to canyons or other steep areas, but impacts would be expected to be minor in other areas. Impacts related to contamination in the East Parcel would be expected to be minor because it is unlikely that the one anticipated mine would be located in or immediately adjacent to remaining steep areas not withdrawn (discussed under Alternative C erosion impacts). However, because of the four anticipated new mines in the South Parcel and the presence of some steep areas not included in the proposed withdrawal under Alternative D, contamination impacts might range from minor to moderate in the South Parcel. Impacts in other areas, which form most of the South Parcel, would be expected to be minor.

Cumulative Impacts

The nature of cumulative impacts under Alternative D related to soil disturbance and increased erosion would be the same as described for Alternative A; however, the magnitude of additional disturbance from RFD-scenario activities based on relative acreages would be expected to be about 30% less for the North Parcel and South parcels and about 50% for the East Parcel.

The nature of cumulative contamination impacts to soil would be the same as described for Alternative A, except less anticipated mineral development means that the total potential area of impacted soil and number of potential impacted sites would be slightly smaller. For the North Parcel, 17 new mines are anticipated to be developed, compared with 18 mines under Alternative A; adding these 17 mines to the eight mines that are reclaimed and currently operating under approved plans of operation would be expected to result in a more than 200% increase in the total number of potentially impacted sites. No cumulative impacts related to soil contamination would be expected to occur in the East and South parcels because no previous or current uranium mining has occurred in these parcels.

Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative A.

4.6 VEGETATION RESOURCES

4.6.1 Impact Assessment Methodology and Assumptions

Quantitative and qualitative approaches used to estimate impacts to vegetation included calculations of vegetation impacts relative to the availability of vegetation in the proposed withdrawal area, the disturbance footprint of mines and exploration sites, and the spatial nature of impacts.

Impacts are quantified where possible; however, some potential impacts to vegetation resulting from future mining activity are largely uncertain. In the absence of quantitative data, the best available science and professional judgment were used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Table 4.6-1 provides thresholds and descriptions used during analysis for vegetation resource impacts. Vegetation species that are classified as special status species are discussed in Section 4.8.

Table 4.6-1. Magnitude and Degrees of Effects on Vegetation Resources

Attribute of Effect	Description Relative to Vegetation Resources
Magnitude	
No Impact	Mining-related activities would not produce impacts to the vegetative character and overall density and diversity of vegetation resources.
Minor	Mining-related impacts would occur to existing vegetation; however, impacts to overall density and diversity of vegetation resources would not be measurable or apparent.
Moderate	Mining-related impacts would occur to existing vegetation; impacts to the overall density and diversity of vegetation resources would be measurable but not apparent.
Major	Mining-related impacts would create a high degree of change within the existing vegetative character; impacts to the overall density and diversity of vegetation resources would be measurable and apparent.

Duration of impacts is quantified where possible; however, some potential impacts to vegetation as a result of future mining activity are largely uncertain. Impacts are described using ranges of the length of time the resource will be affected. Table 4.6-2 provides thresholds and descriptions used during analysis for duration of impacts to vegetation resources.

Table 4.6-2. Duration of Impact Description

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction)
Short-term	Less than 5 years
Long-term	Greater than 5 years

The analysis of vegetation, which includes structure, productivity, vigor, abundance, and diversity, was based on likely changes relative to movement toward or away from current or natural vegetation conditions.

Vegetation is a fundamental and vitally important component of the biological resources in the proposed withdrawal area. The effects of vegetation resulting from implementing any of the proposed alternatives would also affect other resources. Impacts to the vegetation resource could result in reduced biological productivity, weed invasion, and unwanted changes in the composition and structure of vegetation communities. These changes, in turn, could influence forage availability for wildlife and livestock. Where actions result in loss or reduction of vegetative cover and/or soil erosion or compaction, cultural, wildlife, water, soil, and air resources could be impacted.

The direct and indirect effects of mining-related activities on vegetation may vary widely, depending on a variety of factors such as the location of the mine facilities, type of soils, soil moisture, topography, and plant reproductive characteristics. Direct impacts from mine portals and vents include possible emissions of radon in the general vicinity of these mining features. Direct impacts are generally caused by construction activities; the establishment, use, maintenance, closing, or rehabilitation of roads; and the introduction, spread, and treatment of noxious and invasive species. Indirect impacts are generally caused by dust accumulation immediately adjacent to roads and would include lowered vigor or death of plants and changes in plant abundance and/or species composition resulting from modified nutrient cycling as a result of soil compaction and soil erosion.

Exploration, mining, and the construction of new access roads and power lines could result in direct impacts to the following vegetation types: Great Basin Desertscrub, Plains and Great Basin Grassland, Great Basin Conifer Woodland, and Petran Montane Conifer Forest. Direct impacts to vegetation could include injury or loss of vegetation from crushing or removal of plants. The exact acres of vegetation lost by type cannot be estimated because no specific exploration or mine locations have been proposed at this time. Mining-related disturbance would have localized impacts on vegetation community structure and species richness, as well as overall vegetation productivity on an ecosystem level. The magnitude of these impacts cannot be fully understood until specific mine locations are known. The time required for successful reclamation would depend on soil, topography, rainfall, vegetation type, and the reclamation method used.

Indirect impacts on vegetation may include chemical toxicity as a result of uptake of uranium through soil water. Soils containing between 10 and 100 mg/kg of uranium may have adverse effects on vegetation. These effects may include chlorosis, early leaf abscission, and reduction in root growth. As summarized by the USGS (Hinck et al. 2010), there are few data available about the effect of other radionuclides on vascular plants. However, thallium is a radionuclide that occurs in the uranium decay series. Thallium can be released into surface water, sediment, and soil during the mining process. Thallium can be taken up by plant roots and translocated to aboveground vegetation. The effects of thallium include impaired chlorophyll synthesis, impaired seed germination, reduced transpiration, growth reduction, stunting of roots, and chlorosis (Hinck et al. 2010). Polonium is another radionuclide occurring in the uranium decay series that is found in the leaves of plants. However, polonium also occurs naturally in small amounts throughout the earth's crust at levels that preclude chemical toxicity as a primary hazard. Polonium is also not readily translocated by plant tissues. There is no information available for other radionuclides associated with uranium (Hinck et al. 2010). In general, effects of radiation on plants may include growth inhibition, reduced reproductive capacity, and reduced survival. Environmental factors, such as temperature, light, and surrounding vegetation, can influence the response to radiation. Species that reproduce vegetatively (asexually) are more resistant to the effects of radiation than plants that reproduce by seed (sexually) (Hinck et al. 2010).

Indirect effects on the vegetation of the greater Grand Canyon watershed may also include changes in native species richness, abundance, productivity, and structure as a result of the inadvertent introduction of invasive species during the process of mine operations and the associated disturbance. Invasive species not only displace native species, but have the potential to increase the risk of wildfire, in particular cheat grass, as this species is dormant during the hotter months when the risk of fire is greatest throughout the year. Indirect impacts would also include soil erosion (both wind and water), soil compaction, and watershed impacts from construction and installation of mine facilities, drill sites, access roads, and power lines as effective ground cover is decreased. Removal of cryptobiotic soil crusts, which help hold soils in place, would contribute to these impacts within the proposed withdrawal area and adjacent areas.

4.6.2 Compliance with Environmental Regulations and Permitting

Site-specific operating requirements and conditions of approval regarding construction and reclamation measures on BLM and Forest Service lands would be developed during individual plan of operations review and approval (BLM 2007; Forest Service 2007, 2008e). Examples of stipulations or requirement mitigation measures in approved plans of operations include the following:

1. All surface disturbances, including road construction and associated travel, shall be kept to the minimum necessary to accomplish the task. Road upgrade and realignment requests on BLM lands shall include plans for reclamation.
2. All new temporary or existing upgraded roads on BLM lands may require mitigation to reduce the potential adverse impact of fugitive dust as specified by the authorized officer.
3. Where soil characteristics warrant, topsoil shall be stockpiled. Stockpiles will be of a depth and width to maintain soil biotic community health.
4. All surface-disturbing activities on slopes greater than 15% shall include measures to stabilize soils and control surface water runoff. Vehicles will stay on designated driving routes to avoid excessive soil and vegetation disturbance to minimize the introduction and spread of noxious weeds.
5. To prevent fire, all equipment, including small gas engines for generators and water pumps, will have spark arrestors. All equipment on-site and going to and from the site will have chemical fire extinguishers, which are to be readily accessible during drilling operations. Drill rigs and water pumps will have hoses with nozzles with pressure suitable for use in the event of a fire. On-site smoking will be subject to agency rules and guidelines, and no smoking materials such as cigarette butts will be discarded on the ground.
6. Reclamation of all surface disturbances must be initiated immediately upon completion of activities, unless otherwise approved by the authorized officer. Reclamation of disturbed areas shall, to the extent practicable, include contouring disturbances to blend with the surrounding terrain, replacing topsoil, smoothing and blending the original surface colors to minimize impacts to visual resources, and seeding the disturbed areas with a mix specified by the authorized officer.
7. Revegetation efforts must establish a stable biological groundcover equal to that which occurred prior to disturbance. Mulching may be appropriate for conserving moisture and holding seed on-site, thus improving the chances for successful establishment.
8. Roads shall be reclaimed immediately upon termination of the project. Recontouring all cut slopes to approximately the original contour shall be required. Reclaimed roads shall be barricaded or signed to protect them until reclamation is achieved. All existing roads that require upgrading shall be reclaimed to their original dimensions upon completion of the project. Exceptions must be approved in writing by the authorized officer.

4.6.3 Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, approximately 1,364 acres could be impacted by mining. To support the mines, approximately 22.4 miles of new roads and power lines would increase the impact area by approximately 67.6 acres. A total of 317,505 ore haul trips would be required under this alternative. Impacts associated with mining activities would include loss or injury of plants as a result of crushing or removal of plants, burial under piles of extracted material, toxic responses from chemicals and/or radiation hazards, and increased exposure to dust and other contaminants.

Vehicles traveling on roads would deposit dust on individual plants. This could lead to a decrease in plant vigor and a decrease in vegetation productivity adjacent to these roads. Productivity may be reduced as a result of depressed photosynthetic capability over time, after repeated deposition of dust on vegetation during active times of mine operations. Vegetation productivity would be expected to return to pre-project conditions following the completion of reclamation activities, when deposition of dust would not be occurring regularly.

Indirect impacts may also include exposure of vegetation to uranium or other radionuclides via contaminated water, soil, or dust, which may result in the effects described above, including chlorosis, early leaf abscission, and reduction in root growth, reproductive capacity, or survival. The increase of uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Infestation of invasive species may also occur as an indirect effect of vehicular travel along the access roads, as part of mining operations and reclamation. Preventive measures, such as power washing of all construction vehicles prior to their entry onto construction sites and monitoring reclamation sites, would minimize establishment and spread of invasive species as part of reclamation activities.

Vegetation in riparian areas may be affected by increased runoff, flooding, and erosion events as an indirect impact from mining operation activities in upland areas. The increased sedimentation and soil erosion may also occur as a result of construction activities and increased vehicular travel. These impacts could range from minor to moderate, depending on the location of mine facilities, the severity of rain events, and subsequent erosion.

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. Although individually fairly small areas could be disturbed under this alternative, the number of exploration and mining projects anticipated for the North Parcel could result in long-term and apparent differences between the disturbed then reclaimed areas and the surrounding vegetation. Impacts are more likely to be apparent to the vegetation community overall in this parcel because of the total number and acreage of disturbed throughout the parcel. In general, these impacts are estimated to be minor to moderate, depending on the location of the impacts, and are considered a long-term impact, given the fact that impacts would be scattered spatially (30 mining projects; 728 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site) or linear in nature (22.4 miles of access roads, removing approximately 38 acres of vegetation). Although measurable, the decrease in vegetative cover would be considered a minor to moderate impact, given the relatively small areas that would be affected.

4.6.4 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

As a result of withdrawal under Alternative B, approximately 164 acres are anticipated to be impacted by mining. To support the mines, approximately 6.4 miles of new roads and power lines would increase the impact area by approximately 39 acres. No development is anticipated on the East Parcel, and new exploration and mining on the North and South parcels would be limited to valid existing claims. Exploration, mining, and the construction of new access roads would result in impacts to 163 acres on the North Parcel and 1 acre on the South Parcel. These impacts represent approximately 0.02% of the proposed withdrawal area. Total acres of vegetation disturbed is approximately a 71% decrease, compared with Alternative A, and the total number of ore haul trips would be 106,225, a 67% decrease, compared with Alternative A. The types of impacts would be similar to those described under Alternative A; however, the extent of potential impacts to vegetation resources would be reduced under this alternative.

An increase in sedimentation and soil erosion may also occur as a result of construction activities and increased vehicular travel. Vegetation in riparian areas may be affected by increased runoff, flooding, and erosion events as an indirect impact from mining operation activities in upland areas. These impacts could range from minor to moderate, depending on the severity of rainstorms and subsequent erosion.

Impacts to vegetation are similar to those described under Alternative A. When comparing potential impacts of Alternatives A and B, Alternative B provides more protection to vegetation resources within the proposed withdrawal area from uranium mine related impacts than Alternative A.

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. In general, vegetation impacts associated with Alternative B are estimated to be minor and are considered a long-term impact, given the fact that impacts would be scattered spatially (seven mining projects; 11 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site) or linear in nature (6.4 miles of access roads and power lines removing approximately 39 acres of vegetation). Although measurable, the decrease in vegetative cover would be considered a minor impact, given the relatively small areas that would be affected.

4.6.5 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

As a result of withdrawal under Alternative C, approximately 532 acres are anticipated to be impacted by mining. To support exploration and development, approximately 12.1 miles of new roads and power lines would increase the impacts by 72 acres. The types of impacts would be similar to those described under Alternative A; however, the extent of potential impacts to vegetation resources would be reduced under this alternative. All of the Petran Montane Conifer Forest on the South Parcel and riparian vegetation (Kanab Creek) and the majority of Great Basin Conifer Woodland on the North Parcel would be withdrawn from possible mineral exploration and development. Exploration, mining, and the construction of new access roads would result in impacts (such as crushing and removal of plants, dust deposition, and potential for introduction and spread of invasive species) to approximately 532 acres: 320 acres on the North Parcel, 54 acres on the East Parcel, and 158 acres on the South Parcel. This represents approximately 0.05% of the proposed withdrawal area and a decrease of 46%, compared with Alternative A, and the total number of ore haul trips would be 184,065, a 42% decrease, compared with Alternative A.

Under Alternative C, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit general and sensitive species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. In general, vegetation impacts associated with Alternative C are estimated to be minor and considered a long-term impact, given the fact that impacts would be scattered spatially (18 mining projects; 207 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site), or linear in nature (12.1 miles of access roads and power lines removing approximately 72 acres of vegetation). The decrease in vegetative cover would be considered a minor impact, given the relatively small areas that would be affected.

4.6.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

As a result of withdrawal under Alternative D, approximately 951 acres are anticipated to be impacted by mining. To support exploration and development, approximately 19.1 miles of new roads and power lines will increase the impacts by 114 acres. The types of impacts would be similar to those described under Alternative A; however, the potential for impacts to vegetation resources would be reduced under this alternative. The majority of the Petran Montane Conifer Forest on the South Parcel and riparian vegetation (Kanab Creek) and much of the Great Basin Conifer Woodland on the North Parcel would be removed from new exploration and development. Exploration, mining, and the construction of new access roads would result in impacts to approximately 1,065 acres: 688 acres on the North Parcel, 54 acres on the East Parcel, and 209 acres on the South Parcel. This represents approximately 0.09% of the proposed withdrawal area and is a 15% reduction, compared with Alternative A. The number of ore haul trips would be 273,025, a 14% reduction, compared with Alternative A.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternatives C and D both protect these resources from future mining, but Alternative D does not withdraw as much terrestrial habitat, which is occupied by threatened and endangered species. These areas are located in the northeastern and northwestern portions of the North Parcel, where several threatened and endangered plants species occur.

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. Although individually fairly small areas would be disturbed under this alternative, the number of exploration and mining projects anticipated for the North Parcel could result in long-term and apparent differences between the disturbed then reclaimed areas and the surrounding vegetation. Impacts are more likely to be apparent to the vegetation community overall in this parcel because of the total number and acreage of disturbed throughout the parcel. In general, these impacts are estimated to be minor to moderate, depending on the location of the impacts, and are considered a long-term impact, given the fact that impacts would be scattered spatially (26 mining projects; 431 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site), or linear in nature (19.1 miles of access roads and power lines, removing approximately 114 acres of vegetation).

Although measurable, the decrease in vegetative cover would be considered a minor to moderate impact, given the relatively small areas that would be affected.

4.6.7 Cumulative Impacts

The analysis area for vegetation resources is the proposed withdrawal area, Grand Canyon National Park, and the Kanab Creek Wilderness. Mine-related cumulative impacts include the potential impacts of further development of the VANE claims (South Parcel) and Denison's Arizona 1 and EZ-1/EZ-2/What Mine (North Parcel). These actions may result in the loss of vegetation, lower vegetation productivity, higher rates of erosion and sedimentation in drainages/waterways, increased deposition of dust on vegetation adjacent to roadways, introduction and spread of invasive plants, and exposure of vegetation to uranium and its associated radionuclides. Reclamation actions will counter some of the reduction in vegetative cover. Preventive measures to inhibit the spread of invasive plants could curtail infestation by species such as cheatgrass.

Other factors that may augment the effects of the mining projects include recreation, tourism, timber harvesting, livestock grazing, and other management programs. Vehicles that use the same roadways and are not subject to the same preventive measures may act as vectors to carry invasive species seeds into areas under development for mining activities. Recently disturbed soil is readily invaded by such species. Grazing may also increase the chances for invasive species infestation, as livestock animals often carry seeds in their hooves and fur.

Given the relatively small area of surface impact, it is anticipated that none of the alternatives would result in significant cumulative impacts to vegetation resources when added to other past, present, and reasonably foreseeable activities in the withdrawal area.

4.7 FISH AND WILDLIFE

As discussed in Chapter 2, the BLM and Forest Service require the preparation of plans of operation for all uranium mining projects. Plans of operation include performance standards and reclamation measures to minimize or mitigate impacts to fish and wildlife resources consistent with applicable laws and regulations. The BLM RMP for the Arizona Strip Field Office establishes policy to manage resources on the Arizona Strip (North and East parcels) to preserve vital habitat for fish and wildlife species consistent with applicable laws and regulations. As discussed in the Arizona Strip ROD/RMP, essential habitats, important migration routes, required flows, and water quality will be protected and maintained in lentic and lotic systems (BLM 2008b). Actions that degrade riparian habitat or reduce the potential of the area to support riparian vegetation will be modified, restricted, or prohibited consistent with applicable laws and regulations (BLM 2008b). No net loss will occur in the quality and quantity of suitable habitat for endemic fish, amphibians, and aquatic invertebrate species (BLM 2008b).

The Kaibab National Forest manages resources under the Kaibab LRMP/ROD (Forest Service 1988). The Kaibab LRMP/ROD considers the relative values of all renewable resources, including the relationship of nonrenewable resources, such as minerals, to renewable resources and strives for the protection and, where appropriate, improvement of the quality of renewable resources. In particular, the Kaibab LRMP/ROD discusses avoidance or mitigation of impacts on wildlife habitats, including breeding, calving, and fawning areas; requires site-specific survey; and evaluates assessment areas during mining project design and plan (Forest Service 1988). The Forest Service manages vegetation resources in such a manner to maintain no fewer than three age classes of woody riparian species, with 10% of the woody plant cover in sprouts, suckers, seedlings, and saplings (Forest Service 1988).

The impacts discussion of this EIS assumes all mining projects within the study area would comply with applicable environmental regulatory requirements and procedures. Examples of stipulations or requirement mitigation measures in approved plans of operation include equipment and waste fluids are contained at all times and are disposed of at approved off-site disposal facilities; all drill cuttings are confined to a mud pit, and radioactive drill cuttings are encapsulated in sealable metal containers and re-deposited in the drill hole, or removed for appropriate disposal; mud pits are covered with topsoil such that radioactivity levels on the surface are returned to pre-drilling levels; berms are constructed around mine sites to prevent in-flows and out-flows of water (built to withstand 500-year flood events); and operators maintain all roads to assure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other resource values.

Even with these measures, the loss of and disturbance to vegetation and aquatic resources, along with alterations to the topographic features of the area, may impact habitat for numerous species and may result in mortality of individuals. Indirect effects on wildlife include noise, dust, and light impacts resulting from mining and transportation. As a result of groundwater drawdown, surface and groundwater environments may be impacted. These impacts may affect the water quality or quantity of area seeps, springs, and other water bodies within and adjacent to the study area and may result in mortality of aquatic-dependent species such as aquatic plants, algae, benthic invertebrates, amphibians, and fish and other wildlife dependent on these rare surface water resources such as bats.

As discussed in Section 3.4, groundwater found on the North Parcel has geological connections to and appears to have groundwater connectivity to the Virgin River; therefore, a withdrawal in groundwater from the North Parcel could influence aquatic and riparian habitat along the Virgin River.
This groundwater connection is not anticipated to have more than a minor influence on overall water quality and quantity at the Virgin River.

The groundwater flow systems in the study area are divided into smaller perched water-bearing zones and larger regional aquifer systems (Bills et al. 2010). The perched water-bearing zones are contained in unconsolidated alluvium, volcanic rocks, and consolidated sedimentary rocks located 1,000 feet or more above the main regional aquifer systems. These perched zones generally are small and discontinuous in the subsurface. Fractures, faults, sinkholes, and breccia pipes occur throughout the study area and are pathways for downward migration of surface water and groundwater. Collapse features and breccia pipes in particular can intercept precipitation, runoff, and groundwater in perched water-bearing zones and can direct that water deeper into the subsurface. In areas containing mineralized pipes, this process can dissolve trace elements and radionuclides in the deposits and transport them to groundwater deeper in the subsurface (Bills et al. 2010).

Habitats in the Grand Canyon and its environs support a diverse flora and fauna. High-elevation areas of the Kaibab anticline are a mix of Rocky Mountain subalpine conifer forest, montane conifer forest, and subalpine grassland. The canyon lands in the region consist almost entirely of Mohave desertscrub, with isolated areas of riparian habitat that support most of the species diversity in the region (Grand Canyon Wildlands Council 2004). Vegetation has a significant effect on the occurrence and flow of water, both on the surface and in the subsurface. Areas of riparian habitat occur within the proposed withdrawal area, have exceptional biodiversity, and are critical for the plants and animals that live in the area. Many of the springs originate in water-bearing zones in the Redwall and Muav limestones and flow into canyons of the greater Grand Canyon area. These spring habitats support a species diversity that is 100 to 500 times greater than that of the surrounding landscape (Grand Canyon Wildlands Council 2004).

Mining activity can result in changes to these habitats that may increase exposure of the biological resources to chemical elements, including uranium, radium, and other radioactive decay products. Uranium and other radionuclides can affect the survival, growth, and reproduction of plants and animals. The identification of biological pathways of exposure and the compilation of the chemical and radiological hazards for these radionuclides are important for understanding potential effects of uranium mining on the northern Arizona ecosystem.

Certain biological receptors are potentially more susceptible to uranium exposure than others. Herbivores, aquatic species, and burrowing animals are of particular concern, given the likely exposure pathways and available toxicity data (Hinck et al. 2010). Aboveground deposits on soils, plants, and surface water expose a variety of biota to chemical and radiation exposure. Uranium and its decay products can be transported by way of infiltration into groundwater and surface waters. In addition to aquatic exposure pathways, wildlife can be exposed to chemical and radiation hazards through other various pathways, including ingestion of soil and food (prey species), inhalation, and various cell absorption processes. As discussed by the USGS (Bills et al. 2010), some seeps, springs, and other water bodies within the proposed withdrawal area contain high concentrations of dissolved trace elements and radionuclides owing to past mining activities and natural processes of evaporation, weathering, and erosion.

Furthermore, ponds at mine sites can be an attractant to mammals and birds. Other inorganic constituents that commonly co-occur with uranium in breccia pipe deposits (such as arsenic and selenium) do not present radiation hazards, but their chemical toxicities to biota are potentially greater than uranium. Exposure pathways for these other inorganic constituents are likely identical to uranium and would need to be included in any site-specific ecological risk assessment to better characterize hazards to biological receptors (Hinck et al. 2010). Aquatic organisms and plants rely on these water bodies; thus, minor deviations in water quality and quantity could result in mortality of fish and other aquatic organisms or in degradation of their habitat.

Limited research has occurred regarding radionuclides from the ^{238}U decay series related to microbial, plant, and animal species and on effects linked to exposure to uranium and other radionuclides. The USGS (Hinck et al. 2010) compiled available chemical and radiation toxicity information for plants and animals from scientific literature on naturally occurring uranium and associated radionuclides. As summarized by Hinck et al. (2010), the ecotoxicity data of biological responses are best discussed in two major categories: chemical hazards and radiation hazards. Chemicals may attain hazardous concentrations that are toxic to biota in the proposed withdrawal area when encountered through the ingestion of prey and water, incidental ingestion of soil, ingestion of plant materials, inhalation of airborne contaminants, and dermal uptake. These radionuclides also present radiation hazards if exposure pathways are complete and exposure is sufficient to yield adverse effects in receptors. Radiation (ionized, alpha, beta, and gamma) can be harmful to humans, and presumably to wildlife, if the materials are inhaled, swallowed, or absorbed through open wounds (Hinck et al. 2010).

Figures 4.7-1 and 4.7-2 document the potential linkages between chemical and radiation hazards associated with mining and biota. As discussed in more detail in Section 4.4, existing water quality conditions within the proposed withdrawal area already exceed these thresholds in some instances. Species-specific uranium threshold levels were available for two endangered fish species known to inhabit waters adjacent to the proposed withdrawal area and are discussed in more detail in Section 4.8.1. Hinck et al. (2010) suggest that caution be used when directly applying taxa specific threshold values to the proposed withdrawal area, given the unique habitat and life history strategies of flora and fauna in the proposed withdrawal area and the fact that some guidance values are based on models rather than empirical (laboratory or field) data.

The potential severity of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism. For wildlife, the use of subterranean habitats (e.g., burrows) in uranium-rich areas or reclaimed mining areas is of particular concern in the proposed withdrawal area. Certain species of reptiles, birds, and mammals spend considerable amounts of time in subterranean habitats where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and/or hibernating. The inhalation of minute dust particles laden with radon progeny is a major contributor to the annual dose of natural radioactivity received by humans (National Council on Radiation Protection and Measurements 1987). Given the brief summary from the USGS, the environmental fate and transfer of radon, the primary hazards associated with exposure to ecological receptors in the field will be radiation toxicity, primarily from the inhalation routes of exposure.

Herbivores and omnivores may also be exposed through the ingestion of radionuclides that have been aerially deposited on vegetation or concentrated in surface water and deposited on soil at mine sites or nearby seeps, springs, or other water bodies. Benthic invertebrates, amphibians, fish and mammals (including bats) could be directly exposed to radionuclides through water and the consumption of prey species. Terrestrial wildlife and migratory birds could also be exposed to radionuclides, as these species seasonally use these isolated and rare aquatic resources. Migratory birds are addressed in Section 4.7.5.

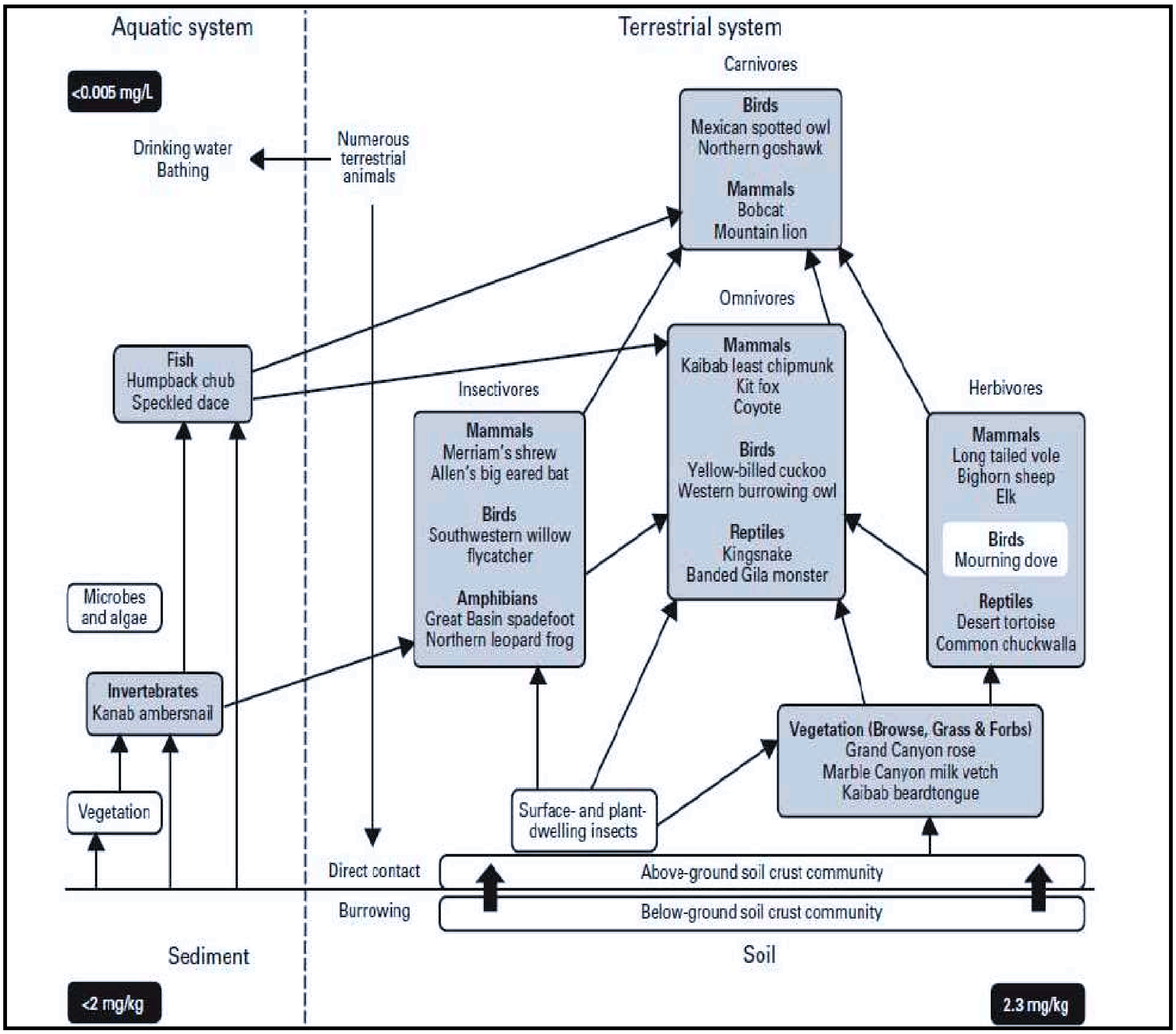

Figure 4.7-1. Potential linkage between chemical and radiation hazards associated with mining operations and biota (from Hinck et al. 2010).

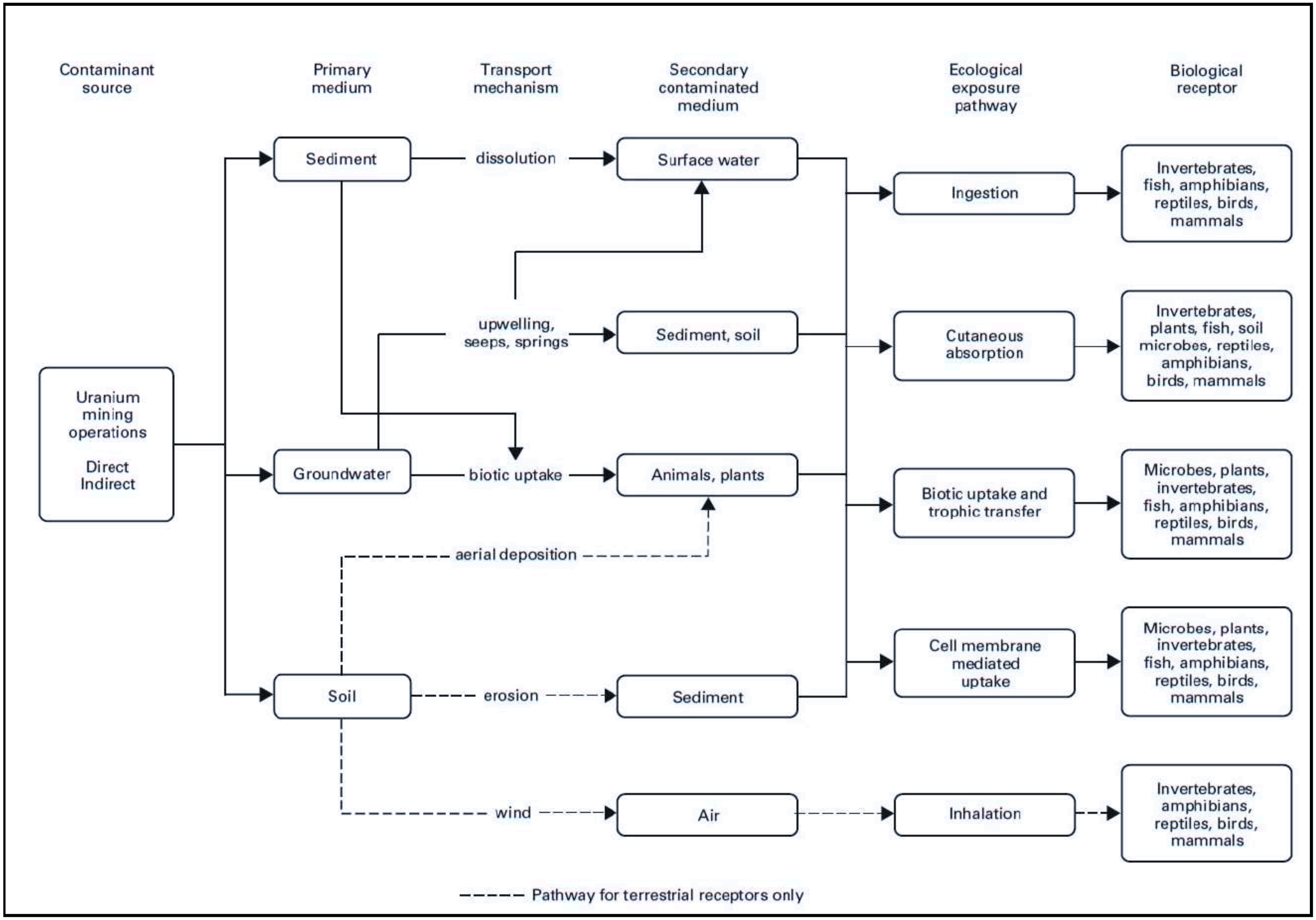

Figure 4.7-2. Exposure Pathways among generalized terrestrial and aquatic habitats (from Hinck et al. 2010).

Chemical toxicity data for algae, cyanobacteria, and aquatic microorganisms are limited, and responses to uranium exposure varied (Hinck et al. 2010). As discussed by Hinck et al. (2010), uranium inhibits the growth of aquatic microflora, diatom survival is reduced, and algae experiences growth inhibition; in addition, aquatic invertebrates, amphibian, and fish responses vary widely and include reproductive impacts and mortality. Toxicity data for aquatic vascular plants are limited, uptake and incorporation of uranium from water to plant tissues yield relatively low tissue residues, and translocation of uranium from root to foliage is low; therefore, foliage generally has lower uranium concentrations than roots (Hinck et al. 2010).

The following range of threshold values, by taxa, were assembled from available data and suggest negative impacts to aquatic biota by uranium radionuclides: algae 1.0 to 36.3 mg/L; benthic invertebrates 0.005 to 0.13 mg/L; mollusks 0.00057 to 0.365 mg/L; amphibians 1.75 to 54.3 mg/L; fish 0.02 to 46 mg/L; and mammals (non-fish-eaters) 0.05 to 16 mg/L (Hinck et al. 2010). Very limited information is available for birds in aquatic settings; however, a threshold of 69 mg/L for non-fish-eaters was documented in Table 6 from Hinck et al. (2010). Uranium and its constituents can also impact terrestrial biota. The following terrestrial environment (soil) threshold values were pulled from available data and suggest adverse impacts to biota by uranium radionuclides: terrestrial plants, 0.01 to 40.0 mGy/h, terrestrial invertebrates 0.2 to 40 mGy/h, mammals, 0.004 to 40.0 mGy/h; and birds, 0.14 to 5 mGy/h (Hinck et al. 2010).

Impacts to wildlife using these thresholds vary from reproductive and growth/developmental impacts to mortality. As discussed in Hinck et al. (2010), very little research has actually been performed to develop taxa specific plant and wildlife threshold levels for uranium or other metals such as, thallium, thorium, bismuth, radium, radon, and polonium. These uranium threshold values discussed above serve as means to generally evaluate the potential impact of direct exposure of radionuclides on wildlife.

4.7.1 Impact Assessment Methodology

Quantitative and qualitative approaches used to estimate impacts to fish and wildlife include calculations of terrestrial, riparian, and aquatic habitat impacts relative to the availability of those resources within the proposed withdrawal area; the disturbance footprint of exploration and mine sites and the spatial nature of those impacts; published literature on disturbance-related impacts to wildlife; and existing agency management plans and reports addressing surface impact management. The spatial boundaries of analysis vary by resource, cross political, administrative, and state boundaries, and were expanded beyond the proposed withdrawal area to include the larger extent of regional drainages to account for seasonal movements, the large geographic range of many species, and the potential for long-term indirect impacts.

For fish and wildlife resources, resource condition indicators include the following:

- acres and type of terrestrial and/or aquatic habitat loss and/or degradation;
- changes in water quality or quantity at aquatic sites;
- changes in migratory and/or foraging behavior;
- avoidance or adaptation of wildlife species to noise source/visual intrusion;
- acres of habitat loss or degradation as a result of establishment of invasive species caused by mineral exploration and development activities; and
- habitat fragmentation of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.

Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Table 4.7-1 provides thresholds and descriptions, and Table 4.7-2 provides durations used during analysis for general fish and wildlife resource impacts. Special status species, which include several aquatic-dependent and terrestrial wildlife species, are discussed in more detail in Section 4.8.

Table 4.7-1. Magnitude and Degrees of Effects on Fish and Wildlife Resources

Attribute of Effect	Description Relative to Fish and Wildlife Resources
Magnitude	
No Impact	Would not produce changes in aquatic, riparian, and/or terrestrial habitat components or impact the behavior or overall viability and distribution of fish and wildlife populations.
Minor	Mining-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components; however, physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs and other water bodies, and impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals (fish and wildlife) may experience reduced viability or mortality; however, these impacts would not alter fish and wildlife distribution in the study area or result in changes to overall fish and wildlife population viability.
Moderate	Mining-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals (fish and wildlife) may experience reduced viability or mortality; these impacts could alter fish and wildlife population distributions in the study area, but would not result in changes to overall fish and wildlife population viability.
Major	Mining-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable and apparent. These impacts would cause reduced viability or mortality of individuals (fish and wildlife) and could threaten the viability and distribution of one or more fish and wildlife population in the study area.

Table 4.7-2. Duration Definition of Effects on Fish and Wildlife Resources

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction)
Short-term	Less than 5 years
Long-term	Greater than 5 years

4.7.2 Incomplete or Unavailable Information

Although some research has been performed, a more detailed, quantitative analysis of the possible effects of chemical and radiation hazards to general wildlife species that occur within the proposed withdrawal area could be contained in future site-specific analyses of proposed new mining projects.

In addition to a more detailed understanding of how chemical and radiation hazards impact wildlife, more precise information on the locations of exploration sites, mine sites, and roads would be useful to better understand the magnitude, extent, and duration of impacts to wildlife and fish species.

As discussed in Bills et al. (2010), only a few trace patterns were found between trace-element concentrations in groundwater and the mining activities. Consequently, patterns or the lack of patterns in trace-element chemistry with respect to mining conditions was considered inconclusive and to merit additional investigations.

A more detailed collection and analysis of additional water-chemistry data from springs and wells in the r- aquifer within the proposed withdrawal area to determine groundwater flow characteristic north of the Colorado River that affect mobility of radionuclides near ore deposits and mined areas would be useful for future project analysis. Such an investigation would require the drilling of new observation wells in this area.

Monitoring of water levels in wells developed in the R-aquifer could provide information about the hydraulic connections between mined areas, springs, and seasonal precipitation in the area.

To assist future project specific assessments, the agencies should establish a network of surface-water and water-quality monitoring sites in Kanab Creek Basin (North Parcel). These sites would allow sampling of runoff that can then be analyzed for total radionuclide flux in this area.

4.7.3 Fish and Aquatic Resources

Direct and Indirect Impacts

Impacts to fish and aquatic resources are expected to occur for each of the alternatives and are discussed below. Impacts to wildlife and migratory birds are discussed in Sections 4.7.4 and 4.7.5, respectively. It should also be noted that many aquatic-dependent species are discussed in Section 4.8, Special Status Species.

Aquatic resources within the proposed withdrawal area are mostly ephemeral drainages that flow directly or indirectly into the Colorado River. Most of the tributaries that drain the north of the Colorado River are ephemeral, except for short perennial reaches supported by groundwater discharge. Kanab Creek is the only perennial stream within the proposed withdrawal area. Kanab Creek, the largest tributary north of the Colorado River, drains 2,360 square miles and contains many breccia pipes, many mines and prospects for copper and other ore, and six uranium mines. South of the Colorado River, all tributaries on the Coconino Plateau are ephemeral, except for short perennial reaches supported by groundwater discharge. On the south, the largest tributaries that drain to the Colorado River are the Little Colorado River and Havasu Creek.

Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, the No Action Alternative, the proposed withdrawal area would remain open to location and entry under the Mining Law. New mining claims could be located, and exploration and development activities would continue to be processed by the BLM or the Forest Service. Alternative A analysis estimates that the removal of 969 acre-feet of water from the R-aquifer over 20 years is equivalent to approximately 30 gpm, or a reduction in flow of approximately 1% to 2% over 20 years. Alternative A estimates that approximately 316 mgal of water would be required over a 20-year period or up to approximately 11 mgal per year. As discussed in Section 3.4, the discharge rate at study area R-aquifer springs range from approximately 1,000 gpm to approximately 100,000 gpm. Groundwater within the North Parcel flows into two major drainages, the Virgin River and Kanab Creek. While an overall 1% to 2% decrease in flow may seem minor over 20 years, this reduction has the potential to produce impacts to the quantity and quality of aquatic and riparian habitats that support a host of aquatic and terrestrial species. A measurable reduction in flow at the Virgin River is not anticipated.

Mining-related impacts on perched aquifers include a potential of reduced flow related to downward migration of flows from the perched aquifer as a result of the mine drill shaft. This in effect, has the potential to reduce flow or dry up seeps and springs connected to the perched aquifer. Perched aquifers, which typically have less flow volumes than springs associated with the R-aquifer, would have a greater magnitude of impacts and are influenced by rain events. Flows at many study area seeps and springs are connected to perched aquifers that deliver as little as a few gallons of water per minute to several hundred gallons per minute. Therefore, a reduction in flow has the potential to impact the density of aquatic and riparian habitats that are linked to perched aquifer sources and could cause the impact magnitude to range from minor to major. The duration of this impact could range from short term to long term, depending on the success of mine reclamation to plug the mine shaft to eliminate downward flow from the perched aquifer. Reductions in quality or quantity of water from springs and seeps within the Colorado River watershed has the potential to have moderate to major impacts on a species' density at a particular seep or spring and may have impacts to the overall distributional range of a species that rely on these rare surface waters within the proposed withdrawal area and adjacent lands.

Impacts to aquatic habitats would further reduce cover and prey species for both aquatic and terrestrial organisms, increased competition for remaining resources, increased predation, and loss of potential dispersal and foraging habitat. Aquatic-dependent individuals may experience reduced viability or mortality; however, these impacts would not likely alter the overall fish and wildlife distribution in the study area or result in changes to overall fish and wildlife population viability. The study area is located in an arid region that may experience extreme drought conditions for many years. During these extreme drought conditions, the additional strain on groundwater (11 mgal per year) has the potential to impact the size and quality of aquatic and riparian habitats. The aquatic resources of the study area are vital regional habitat components for many wildlife species and represent important life-sustaining resources associated with regional wildlife. For a more detailed discussion on wildlife impacts, see Section 4.7.4.

As mentioned, Alternative A could impact water quantity at area seeps, springs, and other water bodies within the study area, including Kanab Creek, which is a significant aquatic resource within a designated wilderness; however, these impacts are not anticipated to alter the overall fish and wildlife distribution in the study area or result in changes to overall fish and wildlife population viability. Impacts associated with acres lost of aquatic and riparian habitat were not calculated but could be assumed to be measurable but not apparent during any given year within the 20-year study time frame. Impacts to water quantity are considered short term in duration because reductions in flow would be eliminated after the mine is closed.

Uranium is naturally present in many surface waters within the proposed withdrawal area. Increased uranium levels in groundwater associated with implementation of Alternative A could impact surface waters (seeps, springs, and other water bodies) in the study area. As is evident with the previously mentioned thresholds, impacts to plants and animals could occur with even minor increases of uranium concentrations. Estimated levels of uranium are anticipated to increase by barely detectable amounts under Alternative A; however, even minor increases in uranium levels could have the potential to impact individual aquatic organisms. Impacts from increased uranium levels in surface waters could occur at every level of the foodweb. These impacts include decreased viability, increased resource competition with other individuals or species that may be more uranium tolerant, and even mortality. The increases of uranium in area surface waters are anticipated to be localized and non-detectable once mixed with the larger flows of the Colorado River. The specific location of a mine along with the type of aquifer (R-aquifer or perched aquifer) impacted would determine the magnitude of impacts.

Some mines have been in interim management mode for decades as world uranium prices fluctuate. When a mine is in interim management mode, portions of the mine are shut down and equipment is possibly even removed; however, there remains a risk of mine-related material, including dust with elevated radioactive levels, migrating off-site. Several recent studies at uranium mines in northern Arizona that are in interim management mode have shown that radiation and chemical hazards are still present in and around the mine sites. Soil and water samples collected documented increased levels of uranium and its decay constituents. Depending on the location of the mine, number of years in operation, and impacts on local aquifers, Alternative A has the potential to impact aquatic resources and organisms within the study area. Impacts could range from minor to major and would be considered long term in duration.

In summary, Alternative A could increase uranium levels at area seeps, springs, and other water bodies and could result in mortality of individuals or reduced viability of individuals; however, these impacts are not anticipated to alter the overall distribution of fish and aquatic organisms in the study area, nor result in changes to overall fish and wildlife population. Although reclamation of breccia pipes can be nearly fully mitigated when a mine is closed (reduce or eliminate uranium and other contaminants from moving into aquifers), the potential for impacts associated with chemical and radiation exposure would remain in aquatic resources for more than 20 years; therefore, the duration of impact is considered long term.

Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Alternative B, the Proposed Action, would withdraw the entire 1,006,545 acres of federal mineral estate within the three parcels for 20 years from operation of the Mining Law, subject to valid existing rights. Alternative B would prohibit the location and entry of new mining claims within the proposed withdrawal area as well as the exploration or development on existing mining claims not supported by a discovery under the Mining Law. On mining claims where valid existing rights are determined to exist, new drilling and mining activities would continue to be processed by the BLM or the Forest Service. Portions of the North Parcel are located adjacent to the Kanab Creek Wilderness management area, which has moderate to high potential for uranium. The Arizona Wilderness Act of 1984 withdrew the Kanab Creek Wilderness to entry under the mining and mineral leasing laws, subject to rights established before the date of its wilderness designation.

The bottoms of Kanab Creek and Snake Gulch form a portion of the northern and western boundaries of the Grand Canyon National Game Preserve, which is also closed to locatable mineral entry. There is a narrow strip of land, north of Snake Gulch and west of Kanab Creek, which is outside the Grand Canyon National Game Preserve but within this wilderness area. Numerous mining claims were located in this portion of the management area prior to its wilderness designation in 1984 and could continue to operate under this and all other alternatives.

Under Alternative B, approximately 355 acre-feet of water would be removed from the R-aquifer over 20 years. This equates to approximately a 66% reduction in water use over Alternative A. Under Alternative B, no development is anticipated on the East Parcel, and new exploration and development on the North and South parcels would be limited to valid existing claims. The portion of the North Parcel that appears to have groundwater connections to the Virgin River would be removed from future mining under this proposal. Under Alternative B, potential impacts to aquatic habitats in the proposed withdrawal area (e.g., in Kanab Creek) are anticipated as a result of possible mining at Pinenut, Kanab North, and Canyon mines. Alternative B estimates that approximately 116 mgal of water would be required over a 20-year period, or up to approximately 5 mgal per year. The magnitude of the impact depends on the location of the mine, potential mine related impacts on perched aquifers, the length of time the mine is operating under an approved plan of operations, and when reclamation occurs.

Impacts as a result of withdrawal under Alternative B would be similar to those under Alternative A; however, given the reduced water use, impacts to the quantity or quality of aquatic resources at area seeps, springs, and other water bodies would not be measurable or apparent and would be considered minor. Under this Alternative, vital surface water resources within the North Parcel would still be impacted by existing mining claims, but with the removal of new mining claims under Alternative B, it would further reduce the amount of impacts to area's aquatic resources. Under Alternative B, these resources are afforded more proposed protection than under Alternative A. Depending on the location of the mine, number of years in operation, and impacts on local aquifers, the impacts are considered long term in duration.

Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Alternative C would withdraw 648,805 acres of federal mineral estate within the three parcels for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw the largest contiguous area identified on the resource overlays with concentrations of biological resources that could be adversely affected by locatable mineral exploration and development (see Figures 2.4-2 through 2.4-4 in Section 2.4.4). The Kanab Creek Wilderness, located adjacent to the North Parcel, is a significant biological resource. Even though this area is removed from future mining projects, this area still contains existing and valid mining claims that could still be operated under this alternative. Alternative C would leave the remaining portion of the proposed withdrawal area with isolated or low concentrations of these resources open to operation under the Mining Law.

Under Alternative C, areas with potential aquatic resources or hydrologic resource value proposed for withdrawal include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major ephemeral drainages on the South Parcel. The portion of the North Parcel that appears to have groundwater connections to the Virgin River would remain available to future mining claims under this alternative. Approximately 581 acre-feet of water would be removed from the R-aquifer over 20 years. This represents a 40% decrease in water use, compared with Alternative A. Implementation of Alternative C would require the use of approximately 190 mgal of water over a 20-year period, or up to approximately 7 mgal per year. The magnitude of the impact depends on the location of the mine, potential mine related impacts on perched aquifers, the length of time the mine is operating under an approved plan of operations, and when reclamation occurs.

Impacts as a result of withdrawal under Alternative C would be similar to those under Alternative A; however, given the reduced water use, impacts to the quantity or quality of aquatic resources at area seeps, springs, and other water bodies would not be measurable or apparent and would be considered minor. Under this alternative, vital surface water resources within the North Parcel would still be impacted by existing mining claims, but with the removal of new mining claims from this area, further reductions in the amount of impacts to area aquatic are anticipated over Alternative A. Alternatives B and C both preserve this portion of the North Parcel from future mining claims; however, Alternative B would use approximately 29% less water than Alternative C. Depending on the location of the mine, number of years in operation, and impacts on perched aquifers, the impacts are considered long term in duration.

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Alternative D would withdraw approximately 292,088 acres of federal mineral estate within the three parcels for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw the contiguous area identified on the resources overlays where there is a high concentration of biological resources that could be adversely affected by locatable mineral exploration and development (see Figures 2.4-5 through 2.4-7 in Section 2.4.5). Alternative D would leave the remaining portion of the proposed withdrawal area with isolated or low concentrations of these resources open to operation under the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

Under Alternative D, approximately 840 acre-feet of water would be removed from the R-aquifer over 20 years. This equates to approximately a 13% reduction in water use, compared with Alternative A. The portion of the North Parcel that appears to have groundwater connection to the Virgin River would remain available for future mining under this Alternative. Under Alternative D, potential impacts to springs or other aquatic habitats in the proposed withdrawal area (e.g., in Kanab Creek) are anticipated as a result of existing mining at Pinenut, Kanab North, and Canyon mines. Alternative D estimates that approximately 274 mgal of water would be required over a 20-year period or up to approximately 11 mgal per year. The magnitude of the impact depends on the location of the mine, potential mine related impacts on perched aquifers, the mine is operating under an approved plan of operations, and when reclamation occurs.

Impacts as a result of withdrawal under Alternative D would be similar to those of Alternative A; however, given the reduced water use, impacts to the quantity or quality of aquatic resources at area seeps, springs, and other water bodies would not be measurable or apparent and would be considered minor. Under this Alternative, vital surface water resources within the North Parcel would still be impacted by existing mining claims, but with the removal of new mining claims from this area, further reductions in the amount of impacts to area aquatic are anticipated over Alternative A. Alternatives C and D both preserve this portion of the North Parcel from future mining claims; however, Alternative C removes more land from future mining and uses approximately 37% less water than Alternative D. Depending on the location of the mine, number of years in operation and impacts on perched aquifers, the impacts are considered long term in duration.

Cumulative Impacts

The analysis area for fish and aquatic resources is the proposed withdrawal area (North, East, and South parcels), the Park, and the North Kaibab Ranger District. This study area has the potential for impacts to springs. Based on the alternatives discussed above, mining would increase groundwater use in the proposed withdrawal area. When combined with the impacts of these other foreseeable projects, all of the alternatives could contribute to higher rates of erosion, an increased potential for sedimentation and contamination in drainages/waterways, and increased water use in the study area. Furthermore, mining-related impacts (downward migration of water) on perched aquifers, when considered in combination with other non-mining related projects and seasonal droughts, could reduce flows at area seeps and springs and contribute to additional impacts on these rare surface water resources which support many species. Given the relatively small area of surface impact and limited water use, it is anticipated none of the alternatives would result in significant cumulative impacts to fish and aquatic resources when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.7.4 General Wildlife Species

Direct and Indirect Impacts

Direct impacts to wildlife would result from habitat alteration and fragmentation, wildlife vehicle collisions, temporary displacement during construction, operation, and reclamation activities, and increased potential to exposure of chemical and radiation hazards associated with bioaccumulation in air, soil, vegetation, and prey species. Acres of impact to wildlife habitat include direct impacts related to acres disturbed by the mine site, roads, and power lines, plus an additional 0.5-mile area around road corridors to account for indirect impacts associated with roadway noise, air, and visual disturbances that could adversely affect animal behaviors. The Transportation Research Board reported that most roadway-related direct and indirect impacts to mammals were undetectable 600 m (1,980 feet) away from a road (National Cooperative Highway Research Program 2008).

The following habitat/vegetation types could potentially be impacted by any of the alternatives: Great Basin Desertscrub, Plains and Great Basin Grassland, Great Basin Conifer Woodland, and Rocky Mountain (Petran) (Brown 1994). The acres of habitat lost by vegetation type cannot be fully estimated at this time because exact locations of exploration and development operations are not known (see Section 4.6 for more discussion on vegetation impacts). Since the location of mines is not known, the exact locations of roads and power lines cannot be determined either.

Table 4.7-3 contains a list of Forest Service MIS considered for analysis. It should be noted that Section 4.8 has many aquatic and terrestrial species that are addressed under the Special Status Species discussion instead of in this section for general wildlife.

Connectivity between aquatic and terrestrial habitats ensures transfers of uranium across environmental habitats. Uranium in ore deposits accumulates in soils and reaches surface waters and sediments through physical processes mediated by natural and/or human-aided mechanisms. Biota of concern, based on the food web include soil microorganisms (including soil crust and microbial communities), aquatic microorganisms, terrestrial and aquatic vascular plants, terrestrial and aquatic invertebrates, fish, amphibians and reptiles, birds, and mammals.

Table 4.7-3. Forest Service Management Indicator Species on the Proposed Withdrawal Area

Management Indicator Species	Scientific Name	Habitat or Habitat Component	Proposed Withdrawal Area
Invertebrates			
Aquatic macroinvertebrates	Includes mayflies, stoneflies, and caddisflies	Riparian	North Parcel
Birds			
Northern goshawk	*Accipiter gentilis*	Late-seral ponderosa pine	South Parcel
Merriam's turkey	*Meleagris gallopavo merriami*	Late-seral ponderosa pine	East and South parcels
Hairy woodpecker	*Picoides villosus*	Snags in ponderosa pine, mixed-conifer, and mixed-conifer with aspen habitats	South Parcel
Juniper titmouse	*Baeolophus ridgwayi*	Late-seral pinyon-juniper and snags in pinyon-juniper	All parcels
Pygmy nuthatch	*Sitta pygmaea*	Late-seral ponderosa pine	East and South parcels
Lucy's warbler	*Vermivora luciae*	Late-seral low-elevation riparian	North Parcel
Yellow-breasted chat	*Icteria virens*	Late-seral low-elevation riparian	North Parcel
Mammals			
Elk	*Cervus elaphus*	Early-seral ponderosa pine, mixed conifer, spruce-fir	South Parcel
Mountain lion	*Puma concolor*	Mixed conifer, pinyon-juniper and early- and late-seral grassland	All parcels
Mule deer	*Odocoileus hemionus*	Early-seral aspen and pinyon-juniper	All parcels
Pronghorn	*Antilocapra americana*	Early- and late-seral grassland	East and South parcels
Abert's squirrel	*Sciurus aberti*	Early-seral ponderosa pine	South Parcel

Uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. Biological soil crusts are assemblages of lichens, fungi, cyanobacteria, and mosses that colonize soil surfaces and represent up to 70% of the living groundcover in arid land environments (Belnap and Lange 2001; Belnap et al. 2005). Biological soil crusts are critical to the transfer of nutrients from seasonal surface runoff (Hinck et al. 2010).

As discussed by the USGS (Hinck et al. 2010), the uptake of uranium and uranium decay series products into animals is similar to that of other metals. Metals that have a similar size and charge to essential trace metal nutrients can be taken up across biological membranes through specific transport mechanisms (for example, sodium/potassium exchange pumps). In general, the liver and kidney are the primary sites of uranium accumulation, with bones, scales, gonads, gills, and gastrointestinal tract variously contributing to the accumulated uranium load (Colley and Thomson 1991; Holdway 1992). Ecotoxicity data were compiled to provide relevant information on chemical hazards to aquatic and terrestrial biota of concern; data were limited to radionuclides of the ^{238}U decay series, including uranium, thallium, thorium, radium, and radon, because they are relatively long-lived (Hinck et al. 2010).

The USGS (Otton et al. 2010) researched past uranium mining impacts at several uranium mines in northern Arizona. Uranium and arsenic were consistently the most abundant trace elements of concern at mined sites. Soil samples were collected within about 420 feet outside the fenced mine site had an average uranium concentration of 27.8 ppm (more than 10 times background concentration) and an arsenic concentration of 12 ppm. Wind appears to be the dominant process dispersing material off-site. The USGS also sampled exploratory mine locations. Although uranium has not been mined at this breccia pipe site, elevated concentrations of uranium and other trace elements are found at these sites and in the vicinity.

The sensitivity of biota to radiation and chemical exposures is also influenced by the size of the organism, i.e., mass (Hinck et al. 2010). For example, large-bodied species are typically more vulnerable to high levels of radiation exposure than small-bodied species because of the greater collision potential (i.e., larger target) between the ionizing radiation and biota (Bytwerk 2006; Higley and Bytwerk 2007). A species' life history may also affect its sensitivity to radiation.

Exposures to high levels of ionizing radiation produce adverse biological effects, such as increased cell death, decreased life expectancy, reduced growth, and altered behavior (Hinck et al. 2010). Alpha particles released during radionuclide decay can cause adverse effects during radiation exposures through ingestion or inhalation in animals or uptake and translocation in plants (Sample et al. 1997). Early developmental stages or life stages with rapid growth are generally more sensitive to radiation exposure than older, relatively mature organisms of the same species. Embryos and fetuses are typically more sensitive to ionizing radiation because these early life stages are dominated by rapidly dividing cells (Brenner et al. 2003; Huettermann and Koehnlein 1978; Riley 1994). Cells undergoing division though mitosis are more susceptible than cells that are not proliferating, and damage to the cellular DNA often results in cell death.

Radiation effects data for soil biota, terrestrial plants, and terrestrial animals include more acute studies than chronic studies and are generally too limited to establish presumptive no-effect levels (Woodhead and Zinger 2003). As discussed by the USGS (Hinck et al. 2010), reproductive capacity is the most frequently studied effect of acute radiation exposure in all biota; however, data on morbidity, mortality, and mutation are also available. Morbidity, or the general health of biota, is the most common effect reported for chronic exposures, although survival and effects on reproduction are also found. Radiation dose rates rarely exceeded 10 mGy/h, and threshold effects levels were generally 0.10 mGy/h.

Soil fauna consist of a large variety of species ranging from protozoa to earthworms and arthropods. Chronic and acute radiation effects data, primarily related to mortality, are available but limited for these receptors (Woodhead and Zinger 2003). For example, effects data for low acute doses (less than 5 mGy/h) were rarely reported, and chronic exposure data relied predominantly on survival. Relatively sedentary animals, such as earthworms, are vulnerable to internal exposure by alpha radiation because they directly forage in the soil and can experience decreases in population sizes after chronic exposure (Woodhead and Zinger 2003). Woodhead and Zinger (2003) reported that soils with elevated natural background levels of radiation (0.001–0.002 mGy/h) contained fewer earthworms and insect larvae, compared with reference areas.

Chemical and radiation effects thresholds for radionuclides are consistently limited to only a few species for most biological receptors, and limited data are available for wildlife species (Hinck et al. 2010). During the USGS study (Hinck et al. 2010), minimal chemical toxicity data were available for microbes, aquatic vascular plants, terrestrial invertebrates, and amphibians, and no data were found for reptiles, birds, or mammalian wildlife. Toxicity data are most abundant, but still limited, for aquatic invertebrates, fish, and laboratory test mammals.

Potential exposure to chemical and radiation hazards could result in direct and indirect impacts to wildlife. Available data suggest negative impacts to biota by uranium radionuclides for terrestrial plants from 0.01 to 40.0 mGy/h, terrestrial invertebrates from 0.2 to 40 mGy/h, mammals from 0.004 to 40.0 mGy/h, and birds from 0.14 to 5 mGy/h (Hinck et al. 2010). The potential magnitude of impacts would be influenced by the life history strategy and habitat requirements of a particular animal (Hinck et al. 2010). For wildlife, the use of subterranean habitats (e.g., burrows) in uranium-rich areas, or reclaimed mining areas, is of particular concern in the proposed withdrawal area. Certain species of reptiles, birds, and mammals spend considerable amounts of time in subterranean habitats, where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and/or hibernating. Herbivores may also be exposed through the ingestion of radionuclides that have been aerially deposited on vegetation or concentrated in surface water at mine sites or nearby seeps, springs, or other water bodies.

Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, approximately 1,364 acres could be impacted by mining. To support the exploration and development projects, approximately 22.4 miles (67.6 acres) of new dirt roads and 22.4 miles (67.6 acres) of new power lines would also be constructed. An average width of 25 feet was used for both roads and power line facility calculations. An estimated 317,505 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of the dirt roads was added to the calculations to account for noise and visual intrusions that could affect wildlife behavior. It was also assumed that the power lines would follow dirt roads and therefore were included in this 0.5-mile indirect impact area. This 0.5-mile area on either side of a new road equates to an additional 22.4 square miles (14,336 acres) of indirect impacts to wildlife habitat. The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts and an additional 14,336 acres of indirect impacts associated with the 0.5-mile area for a total of 15,836 acres impacted, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the most impacts, with approximately 11,540 acres impacted, or 2% of available land within that parcel. The East Parcel would have approximately 1,657 acres impacted, or 1.2% of available land within that parcel. The South Parcel would have approximately 2,638 acres impacted, or 0.8% of available land within that parcel.

Wildlife may be injured or killed by collisions with vehicles traveling on the road system. Impacts from collisions typically affect individuals, although populations could be adversely affected if the species is rare or collisions are frequent. Birds, reptiles, and small mammals are among the species most commonly hit by vehicles. The potential to impact small mammals or other wildlife with small home ranges is possible with the 20-acre mine site but is considered minor based on the amount of available habitat remaining within the proposed withdrawal area. Large mammals with winter range, calving, and/or fawning habitat in the proposed withdrawal area include mountain lions, elk, mule deer, pronghorn, and desert bighorn sheep. Although there would be no targeted protection of critical winter range, calving, fawning, or nesting areas for general wildlife species, impacts are expected to be minimal, given the amount of acres disturbed and the implementation of low speed limits.

Aboveground deposits on soils, plants, and surface water expose a variety of biota to chemical and radiation exposure. Wildlife can be exposed to chemical and radiation hazards through various pathways, including ingestion, of soil and prey, inhalation, and various cell absorption processes. These types of impacts may attain hazardous concentrations that are toxic to biota when encountered in the environment. This type of impact is hard to calculate without the preparation of a site specific risk assessment.

In addition to direct habitat impacts and possible vehicle-wildlife collisions and exposure to chemical and radiation hazards, indirect impacts to wildlife include the following: dust settling on vegetation adjacent to roads could temporarily reduce habitat productivity; and increased noise and visual intrusions could temporarily impact animal behaviors. New roads also increase habitat fragmentation while the roads are in use. Habitat fragmentation varies in magnitude and intensity by wildlife species and location of roads within the proposed withdrawal area. As depicted in Figure 3.7-1, recognized wildlife linkages within the proposed withdrawal area are associated with existing paved roads (U.S. 89A, SR 64, and SR 67) (Arizona Wildlife Linkages Workgroup 2006), although wildlife can and do move anywhere within the entire proposed withdrawal area in search of food and shelter. As part of implementation of Alternative A, it is assumed that new access roads could tie directly into regional paved road; therefore, impacts associated with new access points would create another linear transportation feature within these established wildlife corridors that would need to be studied as part of the plan of operations as well as for the ADOT right-of-way application that is required for temporary construction within an existing transportation corridor.

Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), and long term, as impacts would be scattered spatially and temporally (30 mining projects over 20 years; 728 exploration projects over 20 years). New access roads would be reclaimed when the mine is closed. Access roads would be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but would extend the duration of select roads for as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

As a result of withdrawal under Alternative B, approximately 164 acres are anticipated to be impacted by mining. To support the exploration and development projects, approximately 6.4 miles (19.3 acres) of new dirt roads and 6.4 miles (19.2 acres) of new power lines would also be constructed. An average width of 25 feet was used for both roads and power line facilities. An estimated 106,225 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of new roads was added to the calculations to account for noise and visual intrusions that may affect wildlife behavior. It was also assumed that the power lines would follow the dirt roads, and they were therefore included in this 0.5-mile area. This area equates to an additional 6.4 square miles (4,096 acres) of indirect wildlife habitat impacts. The total acres of disturbance under Alternative B over a 20-year time frame has been calculated at approximately 203 acres of direct impact related to mining, road, and power line impacts and an additional 4,096 acres of indirect impacts associated with a 0.5-mile area, for a total of 4,300 acres impacted, or approximately 0.4% of the proposed withdrawal area. The North Parcel would likely have the greatest amount of impacts, with approximately 4,095 acres impacted, or 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel could have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to wildlife are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

As a result of withdrawal under Alternative C, approximately 532 acres are anticipated to be impacted by mining. To support the exploration and development projects, approximately 12.1 miles (36 acres) of new dirt roads and 12.1 miles (36 acres) of new power lines would also be constructed. An estimated 184,065 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of the dirt roads was added to the calculations to account for noise and visual intrusions that may affect wildlife behavior. It was also assumed that the power lines would follow the dirt roads and therefore were included in this 0.5-mile area. This area equates to an additional 12.1 square miles (7,744 acres) of indirect wildlife habitat impacts. The total acres of disturbance under Alternative C over a 20-year time frame has been calculated at approximately 604 acres of direct impact related to mining, road, and power line impacts and an additional 7,744 acres of indirect impacts associated with a 0.5-mile area for a total of 8,348 acres impacted, or approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 6,216 acres impacted, or 1.1% of available land within that parcel. The East Parcel would have approximately 829 acres impacted, or 0.6% of available land within that parcel. The South Parcel would have approximately1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with high potential wildlife resource value proposed for withdrawal include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these high potential wildlife resources from future mining, Alternative C will benefit general wildlife populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Impacts to wildlife are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.8%), and long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

As a result of withdrawal under Alternative D, approximately 951 acres are anticipated to be impacted by mining. To support the exploration and development projects, approximately 19.1 miles (57 acres) of new dirt roads and

19.1 miles (57 acres) of new power lines would also be constructed. An estimated 273,025 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of the dirt roads was added to the calculations to account for noise and visual intrusions that may affect wildlife behavior. It was also assumed that the power lines would follow the dirt roads and therefore were included in this 0.5-mile area. This area equates to an additional 19.1 square miles (12,224 acres) of indirect wildlife habitat impacts. The total acres of disturbance under Alternative D over a 20-year time frame has been calculated at approximately 1,065 acres of direct impact related to mining, road, and power line impacts and an additional 12,224 acres of indirect impacts associated with a 0.5-mile area, for a total of 13,289 acres impacted, or approximately 1.3% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 10,702 acres impacted, or 1.9% of available land within that parcel. The East Parcel would have approximately 829 acres impacted, or 0.6% of available land within that parcel. The South Parcel would have approximately1,760 acres impacted, or 0.5% of available land within that parcel.

Although proposed withdrawal parcels with high potential wildlife resource value under this alternative are reduced in size, compared with Alternative C, they still include the majority of Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel that are considered high value wildlife habitat. The majority of the vegetation on the South Parcel and riparian habitat (Kanab Creek) and much of the vegetation on the North Parcel would be removed from possible exploration and development.

Impacts to wildlife are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%), and long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

This study area encompasses the seasonal movement corridors and winter and summer ranges of elk, deer, and other large wildlife species in the project area and vicinity, including into surrounding states. When combined with the impacts of these other activities, all of the alternatives could contribute to additional wildlife habitat impacts, a decrease in habitat productivity, an increase in collisions, disturbance-related displacement, poaching of wildlife, and/or fragmentation of wildlife movement corridors.

Improved access into the study area associated with new mine roads could result in an increase in human activity, prompting additional disturbances of animal behavior. Although not designed for recreational purposes, the new roads have the potential to facilitate recreational activities and could lead to displacement of wildlife or decreased use of wildlife corridors related to increased human disturbances. Foot traffic through sensitive areas could disturb wildlife and/or prevent successful feeding or breeding activities.

Given the relatively large area (more than 1 million acres) and the fact that uranium would be processed off-site, it is anticipated none of the alternatives would result in significant cumulative impacts to wildlife resources when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.7.5 Migratory Birds

Direct and Indirect Impacts

Impacts to migratory birds would result from habitat alteration and fragmentation, vehicle collisions, and possible uranium contamination related to bioaccumulation in prey species and increased levels in ponds and fluid pits around mine sites. The sensitivity of biota to radiation and chemical exposures is also influenced by body size. As discussed by the USGS (Hinck et al. 2010), large-bodied species are typically more vulnerable to high levels of radiation exposure than small-bodied species because of the greater collision potential between the ionizing radiation and biota (Bytwerk 2006; Higley and Bytwerk 2007). A species' life history may also affect its sensitivity to radiation. Birds may be at greater risk to radiation exposure than other wild vertebrates because of their natural history related to foraging and ingestion of grit, which effectively increases radiation dose (Driver 1994).

The types of impacts would be similar to those described previously in 4.7.3, Fish and Aquatics, and 4.7.4, General Wildlife, and would include habitat alteration, resulting in a decrease in vegetation productivity, which would affect food supply, nest damage or injury to young during the breeding season, collisions with vehicles, and displacement from breeding or wintering areas during mining and reclamation. As discussed in Section 4.7.4, impacts to aquatic sites affect the entire food web, including migratory birds. Under the withdrawal proposal, exploration and development may still continue on valid mining claims located before the proposed withdrawal. These pre-existing mining claims occupy varying percentages of each of the proposed withdrawal parcels: for the North Parcel, approximately 474 square miles, or 49.8% of the area; for the East Parcel, approximately 4.4 square miles, or 1.9% of the area; and for the South Parcel, approximately 149 square miles, or 29% of the area. Because none of the alternatives would extinguish valid existing rights, uranium mining is projected to take place under all of the alternatives analyzed. The alternative with the least amount of impacts to wildlife habitat from new mineral exploration and development would result in the fewest impacts to migratory birds.

Impacts of Alternative A: No Action (No Withdrawal)

Acres of direct and indirect impacts to migratory bird habitat would be identical to acres of vegetation disturbances, i.e., approximately 1.5% of the total habitat acres available in the proposed withdrawal area. Migratory birds may be attracted to new buildings and power pole structures as well as new water sources that may be associated with a mine. A total of 19.1 miles of new roads and power lines would be constructed for mine access, and the total number of ore haul trips would be 317,505, which has the potential to increase impacts, including mortality with migratory birds.

In addition to physical habitat losses or degradation, bioaccumulation impacts of uranium and other metals may occur to migratory birds if Alternative A is implemented. These impacts include reduced individual viability from reduced prey items and/or from reproductive and cell mutations to mortality related to chemical and radiation exposure. Exposures to high levels of ionizing radiation produce adverse biological effects, such as increased cell death, decreased life expectancy, reduced growth, and altered behavior. Factors related to the location of a mine and the duration of operations could influence the magnitude of these impacts on migratory birds. Mines that secondarily impact perched aquifers could have significant effects on smaller seeps and springs. Kanab Creek is a major migratory bird attractant that is currently impacted by past mining operations. If several additional mines were to operate in the general vicinity of Kanab Creek, this vital resource may experience additional, long-term habitat-altering affects.

As a result of implementation of Alternative A, mining-related impacts could occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur and be measurable but not apparent. Therefore, impacts to migratory birds could be considered minor to moderate in magnitude and long term in duration.

Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Impacts to migratory bird habitat associated with Alternative B would be similar to those described for Alternative A; however, the extent of impacts to migratory birds would be reduced under this alternative. No development is anticipated on the East Parcel, and important stopover habitat, such as Kanab Creek on the North Parcel and the area adjacent to Marble Canyon on the East Parcel, would not be subject to mineral exploration and development. Furthermore, new development on the North and South parcels could continue on valid mining claims located before the proposed withdrawal. Impacts to acres of migratory bird habitat would be identical to those described for vegetation—approximately 0.02% of the total habitat acres in the proposed withdrawal area. A total of 6.4 miles of new roads and 6.4 acres of new transmission lines would be constructed for mine access, and the number of ore haul trips would be 106,225, which has the potential to increase impacts, including mortality with migratory birds.

As a result of implementation of Alternative B, mining-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components as a result of mines from existing valid claims. These existing claims include many surrounding Kanab Creek in the North Parcel, which is considered a significant regional resource for migratory birds. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur but would not be measurable or apparent. Therefore, impacts to migratory birds associated with implementation of Alternative B could be considered minor in magnitude and long term in duration.

Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Impacts to migratory birds associated with Alternative C would be similar to those described in Alternative A; however, the extent of impacts to migratory birds would be reduced under this alternative. Potentially important migration stopover habitat would be withdrawn from mineral development; Kanab Creek on the North Parcel and areas adjacent to Marble Canyon on the East Parcel. Impacts to acres of migratory bird habitat would be identical to those described for vegetation; approximately 0.05% of the total habitat acres in the proposed withdrawal area could be impacted. A total of 12.1 miles of new roads would be constructed for mine access, a 46% decrease, compared with Alternative A, and the number of ore haul trips would be 184,065, a 42% decrease, compared with Alternative A.

As a result of implementation of Alternative C, mining-related impacts could occur to aquatic, riparian, and/or terrestrial habitat components as a result of mines with existing valid claims. As a result of mining operations, including those that could occur on lands surrounding Kanab Creek in the North Parcel, which is considered a significant regional resource for migratory birds. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur but would not be measurable or apparent. Therefore, impacts to migratory birds associated with implementation of Alternative C would be considered minor in magnitude and long term in duration.

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Impacts to migratory birds under Alternative D would be similar to those described for Alternative A; however, the potential for impacts to migratory birds would be reduced under this alternative. Under this alternative, potentially important migration stopover habitat would be withdrawn from new mineral development: Kanab Creek on the North Parcel and areas adjacent to Marble Canyon on the East Parcel. Impacts to acres of migratory bird habitat would be identical to those described for vegetation: approximately 0.09% of the proposed withdrawal area would be affected. A total of 19.1 miles of new roads would be constructed for mine access, and the number of ore haul trips would be 273,025, which is a 14% reduction, compared with Alternative A.

As a result of implementation of Alternative D, mining-related impacts could occur to aquatic, riparian, and/or terrestrial habitat components as a result of mines with existing valid claims. As a result of mining operations, including those that could occur on lands surrounding Kanab Creek in the North Parcel, which is considered a significant regional resource for migratory birds. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur but would not be measurable or apparent. Therefore, impacts to migratory birds associated with implementation of Alternative D would be considered minor in magnitude and long term in duration.

Cumulative Impacts

The analysis area for migratory birds is the proposed withdrawal area (North, East, and South parcels), and a 0.5-mile buffer around this area. When combined with the impacts of these other activities, all of the alternatives could contribute to additional migratory bird habitat impacts, a decrease in habitat productivity, an increase in avian collisions and nest destruction, and disturbance-related displacement of migratory birds.

Given the relatively small area of surface impact, it is anticipated that none of the alternatives would result in significant cumulative impacts to migratory birds when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8 SPECIAL STATUS SPECIES

Table 3.8-1 lists all special status species that may occur within or in close proximity to the proposed withdrawal area. It has been determined by agency resource specialists that some of those species would not be affected by actions proposed in this EIS. These species are therefore not analyzed further in this document. Table 4.8-1 lists special status species that will not be discussed in further detail, along with the rationale for their exclusion from further analysis.

Table 4.8-1. Species Excluded from Further Analysis

Species	Documented within the Study Area?	ESA Status	Rationale for Excluding from Further Analysis
Birds			
California least tern (*Sterna antillarum browni*)	No	Endangered w/CH	This species is known from the Lower Colorado (below Lake Mead). No impacts to species or critical habitat are anticipated because of the distance from the proposed withdrawal area (i.e., no direct disturbance to individuals from mining activities would occur, nor would critical habitat alterations or destruction occur).
Small Mammals			
Black-footed ferret (*Mustela nigripes*)	No	Endangered w/o CH	No significant prairie-dog populations are located near the proposed withdrawal area that would support the species; data from the AGFD indicate dispersal movement into the proposed withdrawal area is not likely because of the species' distance from the proposed withdrawal area.
Southwestern river otter (*Lontra canadensis sonora*)	No	No	The nearest confirmed sighting of this species is along the Colorado River below Lake Mead; no impacts to species or habitat are anticipated because of the distance from the proposed withdrawal area. Because of large volume of water in the Colorado River below the proposed withdrawal area, potential uranium levels in water would be diluted and undetectable.

Table 4.8-1. Species Excluded from Further Analysis (Continued)

Species	Documented within the Study Area?	ESA Status	Rationale for Excluding from Further Analysis
Small Mammals, continued			
Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)*	No	Endangered w/o CH	The nearest confirmed sighting of this species is southwest of the proposed withdrawal area. There would be no impacts to the species, as the distance and topographic location is hydrologically unrelated; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Plants			
Jones cycladenia (*Cycladenia humilis* var. *jonesii*)	No	Threatened w/o CH	The closest population of the species is within the Lone Butte ACEC, located several miles from the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Welsh's milkweed (*Asclepia welshii*)	No	Threatened w/CH in UT	The closest population of the species is located within the Paria Canyon–Vermilion Cliffs Wilderness, located several miles from the proposed withdrawal area. There would be not impacts to this species or designated critical habitat, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Pipe Springs cryptantha (*Cryptantha semiglabra*)	No	No	Species population range is confined to a small area outside of Fredonia. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area and the lack of ore hauling routes adjacent to occurrences of the species.
San Francisco Peaks groundsel (*Packera franciscana*)	No	Threatened w/CH	Species population range is confined to a small area outside the proposed withdrawal area. There would be not impacts to this species or designated critical habitat, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Navajo sedge (*Carex specuicola*)	No	Threatened w/CH	Species population range is confined to a small area outside the proposed withdrawal area. There would be not impacts to this species or designated critical habitat, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Arizona cliffrose (*Purshia subintegra*)	No	Threatened w/o CH	Species population range is confined to a small area outside the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Arizona bugbane (*Cimicifuga arizonica*)	No	Conservation Agreement	Species population range is confined to a small area outside the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Mt. Trumbull beardtongue (*Penstemon distans*)	No	No	Populations are known from Whitmore, Parashant, and Andrus Canyons within the Shivwits Plateau. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
September 11 stickleaf (*Mentzelia memorabilis*)	No	No	The species is located northwest of the proposed withdrawal area and is therefore not influenced by mining projects; there would be no impacts, as there is no hydrology link to surface waters and no airborne impacts are likely because of the distance from the proposed withdrawal area.
Silverleaf sunray (*Enceliopsis argophylla*)	No	No	The closest population of the species is located near Lake Mead and below Hurricane Cliffs. There would be no impacts, as there is no hydrology link to surface water or perched aquifers; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Sticky wild buckwheat (*Eriogonum viscidulum*)	No	No	The closest population of the species is located west of the Virgin River. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.

Table 4.8-1. Species Excluded from Further Analysis (Continued)

Species	Documented within the Study Area?	ESA Status	Rationale for Excluding from Further Analysis
Plants, continued			
Gierisch mallow (*Sphaeralcea gierischii*)	No	Candidate	The closest population of the species is located more than 30 miles west of the proposed withdrawal area and is known in Arizona from the vicinity of Black Rock Gulch, Black Knolls, and Pigeon Canyon. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Holmgren milkvetch (*Astragalus holmgreniorum*)	No	Endangered w/CH	The closest population of the species is located more than 50 miles northwest of the proposed withdrawal area. There would be not impacts to this species or designated critical habitat, as there is no hydrology link to surface water; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus*)	No	No	The species is located northwest of the proposed withdrawal area and is therefore not influenced by mining projects; there would be no impacts, as there is no hydrology link to surface waters and no airborne impacts are likely because of the distance from the proposed withdrawal area.
Fish			
Apache trout (*Oncorhyncus gilae apache*)	No	Threatened w/o CH	This species occurs in the North Canyon Creek with no hydrologic link. This species is also located within the headwater reaches of the Little Colorado, Salt, and Blue rivers. There would be no direct impacts, as there is no hydrology link to surface waters.
Bonytail chub (*Gila elegans*)	No	Endangered w/CH	This species is known from the Lower Colorado (below Lake Mead). There would be not impacts to this species or designated critical habitat, as because of the distance from the proposed withdrawal area.
Little Colorado Spinedace (*Lepidomeda vittata*)	No	Threatened w/CH	This species is endemic to the Little Colorado River. There would be not impacts to this species or designated critical habitat, as because of the distance upstream from the proposed withdrawal area.
Reptiles and Amphibians			
Chiricahua leopard frog (*Lithobates* [*Rana*] *chiricahuensis*)	No	Threatened w/o CH	The closest known population of this species is located more than 100 miles south of the proposed withdrawal area within the Verde River Watershed. There would be no direct impacts, as there is no hydrology link to surface waters.
Northern Mexican gartersnake (*Thamnophis eques megalops*)	No	Candidate	The closest known population of this species is located more than 100 miles south of the proposed withdrawal area within the Verde River Watershed. No direct impacts are anticipated because of the distance from the proposed withdrawal area.
Desert tortoise (*Gopherus agassizii*) (Mojave pop.)	No	Threatened w/CH	This species occurs approximately 40 miles west of the proposed withdrawal area. There would be no impacts to the species or critical habitat. No direct impacts are likely because of the distance from the proposed withdrawal area.
Desert tortoise (*Gopherus agassizii*) (Sonoran population)	No	Candidate	This species occurs approximately 40 miles southwest of the proposed withdrawal area. The range of this species is limited by habitat change imposed by the Mogollon Rim. No direct impacts are likely because of the distance from the proposed withdrawal area.

Note: CH = Critical habitat.

4.8.1 Impact Assessment Methodology

As discussed in more detail in Chapter 2, the existing regulatory framework requires that all plans of operation be subject to subsequent site-specific NEPA analyses in compliance with laws, regulations, and policies and in conformance with applicable RMPs or forest plans. Both the BLM and Forest Service require a detailed plan of operation for proposed mine development projects. Based on site-specific analysis and consistent with applicable laws and regulations, mitigation and conservation measures are developed to avoid or minimize anticipated impacts. Site-specific analysis of effects to threatened, endangered and proposed species is required for compliance with ESA regulations and agency management policies.

Potential adverse effects could be avoided or minimized.

For purposes of this EIS, quantitative and qualitative approaches used to estimate impacts to special status species include 1) calculations of vegetation/habitat impacts relative to the availability of these resources within the proposed withdrawal area; 2) the disturbance footprint of mines and exploration sites and the nature of impacts; 3) calculations of water use relative and flows at nearby springs; 4) published literature on disturbance-related impacts to wildlife; and 5) existing agency management plans and reports that address surface impact management.

The spatial boundaries of analysis vary by resource and cross political and administrative boundaries but were established to accommodate concerns, given the large home ranges of many species and the potential for long-term indirect impacts to aquatic and terrestrial species. Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Tables 4.8-2 and 4.8-3 provide thresholds and descriptions used during analysis of fish and wildlife resources impacts.

Table 4.8-2. Magnitude and Degrees of Effects on Special Status Species

Attribute of Effect	Description Relative to Special Status Species
Magnitude	
No Impact	Would not produce changes in aquatic, riparian, and/or terrestrial habitat components or impact the behavior or overall health of special status species.
Minor	Mining-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components; however, physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs and other water bodies, and impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals (special status species) may experience reduced viability or mortality; however, these impacts would not alter the distribution of special status species in the study area or result in changes to overall special status species' population viability.
Moderate	Mining-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals (special status species) may experience reduced viability or mortality; these impacts could alter the distributions of special status species in the study area but would not result in changes to overall special status species' population viability.
Major	Mining-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs, and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable and apparent. These impacts would cause reduced viability or mortality of individuals (special status species) and could threaten the viability and distribution of one or more special status species population in the study area.

Table 4.8-3. Duration Definition of Effects on Special Status Species

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction) up to one year.
Short-term	Less than 5 years
Long-term	Greater than 5 years

4.8.2 Incomplete or Unavailable Information

- A more detailed, quantitative analysis of the possible effects of chemical and radiation hazards to springs and waterways in the Park, and more precise information on the locations of exploration sites, mine sites, and roads would be useful.
- A more thorough quantitative data investigation of water chemistry in the Grand Canyon region would be helpful to better understand groundwater flow paths, travel times, and contributions from mining activities, in particular on the north side of the Colorado River.
- As presented in Bills et al. (2010), patterns or lack of patterns, in trace-element chemistry with respect to mining conditions was considered inconclusive and merit additional investigations.
- Quantitative data of terrestrial and aquatic bio receptors across taxa within the Grand Canyon watershed are not available to ascertain potential uranium contamination and bioaccumulation impacts related to mining activities.

4.8.3 Threatened, Endangered, and Candidate Species

Table 3.8-2 provides details of the 36 federally listed species being considered in this EIS and their possible occurrence within the proposed withdrawal area. As detailed in Table 4.8-1 and as determined by agency resource specialists, a total of 18 of these species would not be affected by actions proposed in this EIS. The remaining 18 species will be analyzed in more detail in the following impact discussions. ACECs in the proposed withdrawal area established to protect federally listed plants and include Moonshine Ridge and Johnson Spring for Siler pincushion cactus (listed threatened) on the North Parcel, and Marble Canyon for Brady pincushion cactus (listed endangered) on the East Parcel. ACECs in the proposed withdrawal area afford additional protection for federally listed. Outside established ACECs, mining-related activities could impact Siler pincushion cactus, Fickeisen plains cactus (candidate species) on the North and East parcels, and Paradine (Kaibab) plains cactus on the East Parcel.

Direct and Indirect Impacts

As discussed in Section 4.7, mineral exploration and development under each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. As detailed in Table 4.7-3, numerous special status species, including several federally listed as either threatened, endangered, or candidate species, are thought to inhabit or use biological resources within or adjacent to the proposed withdrawal area. For a more detailed discussion on aquatic and terrestrial habitat impacts, see Sections 4.7.3 and 4.7.4. Connections between aquatic and terrestrial habitats ensure transfers of uranium across environmental habitats. Uranium in ore deposits accumulates in soils and reaches surface waters and sediments through physical processes mediated by natural and/or human-aided mechanisms. Threatened and endangered species discussed in more detail in this EIS include vascular plants, invertebrates, fish, amphibians, reptiles, and birds.

Riparian habitat in the Grand Canyon region, including within the North Parcel and adjacent to the South and East parcels, supports a diverse flora and fauna. These riparian areas have exceptional biodiversity and are critical for the plants and animals that live in the area. Many of the riparian areas are supported by springs that originate in water-bearing zones in the Redwall and Muav limestones and flow into canyons of the greater Grand Canyon area. These spring habitats support a species diversity that is 100 to 500 times greater than that of the surrounding landscape (Grand Canyon Wildlands Council 2004). Mining activity can result in changes to these habitats that may increase exposure of the biological resources to chemical elements, including uranium, radium, and other radioactive decay products. Uranium and other radionuclides can affect the survival, growth, and reproduction of plants and animals.

Direct and indirect impacts to threatened and endangered plant and animal species could result from habitat alteration and fragmentation, which could impact overall health of the plant or result in an increase in mortality. Because many species have small home ranges and very narrow habitat requirements, even small modifications to vegetation and soils could lead to pronounced effects on the species by reducing suitable habitat; facilitating weed invasion; increasing erosion; and increasing opportunities for mortality through clearing, crushing, trampling, or reducing cover items, thereby increasing predation rates by other wildlife.

Uranium deposits on soils, plants, and surface water can expose a variety of biota to chemical and radiation exposure. Figures 4.7-1 and 4.7-2 document the potential linkages between chemical and radiation hazards associated with mining and biota. Uranium and its decay products can be transported by way of infiltration into groundwater and surface waters. In addition to aquatic exposure pathways, wildlife can be exposed to chemical and radiation hazards through various pathways, including ingestion of soil and food (prey species), inhalation, and various cell absorption processes. As discussed by the USGS (Bills et al. 2010), some streams, seeps, and springs within the proposed withdrawal area contain high concentrations of dissolved trace elements and radionuclides owing to past mining activities and natural processes of evaporation, weathering, and erosion. Aquatic organisms and plants rely on these water bodies, and minor changes in water quality and quantity could result in mortality of fish and other aquatic organisms or in degradation of their habitat.

Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, approximately 1,364 acres could be impacted by mining. To support the exploration and development projects, approximately 22.4 miles of new roads and power lines would also be constructed. An estimated 317,505 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. If Alternative A is implemented, approximately 2% of the available land within the North Parcel could be impacted, approximately 1.2% of the available land for the East Parcel could be impacted, and approximately 0.8% of available land within South Parcel could be impacted.

The potential to impact threatened or endangered species could result from physical land disturbances associated with exploration and mine sites, as well as roadways and power line facilities. These plants include Brady pincushion, sentry milkvetch, Fickeisen plains cactus, Siler pincushion cactus, and Paradine (Kaibab) plains cactus. In addition to direct habitat impacts, indirect impacts to threatened and endangered plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species.

Birds may be injured or killed by collisions with vehicles traveling on the road system. Birds of prey, including bald eagle, California condor, Mexican spotted owl, and American peregrine falcon, may be impacted by physical land disturbances associated with mining and increased risk of injury as a result of traffic power lines. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species. Impacts to riparian habitats and water quality anywhere within the proposed withdrawal area could impact these bird species, as well as the southwestern willow flycatcher, found along Kanab Creek (North Parcel), and Yuma clapper rail, found along the Virgin River. The location of the mine facility and the influence of the mine on the quantity and quality of groundwater and surface flows at seeps, springs, and other bodies of water could influence the magnitude of these impacts on these bird species.

Impacts to riparian habitat and water quality of surface water could also affect fish, amphibian, and invertebrate species. Fish species associated with the Colorado River include the humpback chub and razorback sucker. These fish could be impacted by mining on any of the proposed withdrawal parcels. A portion of the North Parcel could have some influence on groundwater that also feeds surface flows along the Virgin River; therefore, several fish associated with the Virgin River, although unlikely, could have a potential to be impacted by implementation of Alternative A. These fish include the Virgin River chub, virgin spinedace, and woundfin. The location of the mine facility within the northwestern portion of the North Parcel and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influence the magnitude of these impacts on these Virgin River species.

Impacts to riparian habitats and water quality could affect several amphibian species and an aquatic-dependent invertebrate. These species include the relict leopard frog and Kanab ambersnail. The location of the mine facility and the influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs could influence the magnitude of these impacts on these amphibian and invertebrate species.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts on the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads will be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres could be impacted by mining. To support the exploration and development projects, approximately 6.4 miles of new roads and new power lines would also be constructed. An estimated 106,225 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, involving as much as approximately 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel could have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts to the Little Colorado River (South Parcel) and within the East Parcel and to resources associated with the Colorado River and Marble Canyon. Within the North Parcel, this alternative provides better protection to threatened and endangered plant species than does implementation of Alternative A.

Impacts to species are similar to those described under Alternative A; however given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer mining-related impacts on groundwater, and fewer haul trips generated) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Under Alternative C, approximately 532 acres could be impacted by mining. To support the exploration and development projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 184,065 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, involving as much as approximately 1.1% of available land within that parcel. The East Parcel could have approximately 0.6% of available land within that parcel. The South Parcel could have approximately 1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C could benefit threatened and endangered species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer mining-related impacts on groundwater, and fewer haul trips generated) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.8%) and the reduced potential for future mining near higher valued habitat, and are considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres could be impacted by mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 273,025 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would have the most impacts, involving as much as approximately 1.9% of available land within that parcel. The East Parcel could have approximately 0.6% of available land impacted. The South Parcel could have approximately 0.5% of available land impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit threatened and endangered species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat, which is occupied by threatened and endangered species. These areas are located in the northeastern and northwestern portions of the North Parcel, where several threatened and endangered plants species occur.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%), and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

This analysis area encompasses foraging habitat for the Mexican spotted owl and California condor, whose distribution extends beyond the proposed withdrawal area. The analysis area also includes nesting habitat for Mexican spotted owl and California condor, nesting habitat for yellow-billed cuckoo, springs occupied by Kanab ambersnail, and occupied habitat for sentry milkvetch, humpback chub, razorback sucker, Virgin River chub, woundfin, and Virgin River spinedace. When combined with the impacts of other federally approved projects and agency management activities, all of the alternatives could contribute to direct habitat impacts, a decrease in habitat productivity, and an increase in the potential for disturbance, mortality, or injury of federally listed species. Critical habitat for the Mexican spotted owl would not be impacted, as these areas are already designated as a wilderness and removed from future mining activities.

Given the relatively small area of surface impact and the ESA requirements concerning impacts to listed species and critical habitat, all of the alternatives would result in minor and less than significant cumulative impacts to threatened, endangered, and candidate species when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area. The ESA requires consultation for Federal actions that may affect listed species or designated critical habitat and is intended to avoid or minimize adverse effects. The ESA does prohibit Federal agencies from implementing actions that would result in jeopardizing the continued existence of a listed species or adversely modifying or destroying critical habitat. Project-specific species surveys will be required prior to future mining within the proposed withdrawal area.

Conservation Measures

The following general measures could be considered when the BLM or FS authorizes surface-disturbing activities in the proposed withdrawal area:

- All surface-disturbing activities within a special status species’ ACEC or wildlife habitat area may be restricted seasonally to a period when the species is not active. This determination would be made by a BLM or Forest Service wildlife biologist in coordination with the AGFD and USFWS.
- Special status species habitat surveys will be required whenever surface disturbances occur within an area of known or suspected occupancy by special status species. Field surveys will be conducted during the appropriate time of year when detection of the species is most likely to occur. Based on the results of surveys, appropriate buffer zones will be identified.
- All surface disturbing activities will be restricted to remain 0.25 mile away from seeps, springs, and other drainages, whether flowing or not. This distance may be modified when specifically approved in writing by the BLM or Forest Service.

- All surface-disturbing activities would include conservation to reduce impacts to special status species and their habitat. Conservation measures developed for each listed or proposed species would be applied to any proposed project within the habitat of that species. Analysis of impacts and determinations of effects would include any and all mitigation and conservation measures.
- Prior to any surface-disturbing activity, a special status species review would occur to determine whether any such species would be present in the project area. The following species-specific measures would be applied to management actions in special status species habitats in the proposed withdrawal area (BLM 2008b; Forest Service 2008d). Necessary modifications of the conservation measures or impacts to federally protected species and habitat during implementation of management actions would be documented by the BLM or Forest Service biologist and coordinated with the USFWS. Impacts to these listed plant species are considered negligible and would result in little or no impact because mines and associated linear features (roads and transmission lines) can be located away from known locations. Provided below are conservation measures for California condor and Mexican spotted owl. California condor measures are from BLM (2008b). Mexican spotted owl measures are from Forest Service (2008d); more specific guidelines are described in greater detail in the Kaibab National Forest LRMP/ROD (Forest Service 1988).

CALIFORNIA CONDOR

- Management guidance for all BLM-authorized actions on the Arizona Strip states that immediately prior to the start of an authorized or permitted project, the BLM would contact personnel monitoring California condor locations and movements on the Arizona Strip to determine the locations and status of condors in or near the project area.
- The BLM or Forest Service would request that permit holders notify the wildlife team lead if California condors visit the worksite while permitted activities are underway. Project activities would be modified, relocated, or delayed if those activities could have adverse effects on condors.
- If California condors visit a worksite while activities are underway, the on-site supervisor would notify the wildlife team lead. Project workers and supervisors would be instructed to avoid interacting with condors. Project activities would be modified, relocated, or delayed if those activities could have adverse effects on condors. Operations would cease work until the bird leaves on its own or until techniques are employed by permitted personnel that result in the individual condor’s leaving the area.
- Where condor nesting activity is known within 0.5 mile of activities that include operating heavy machinery, the BLM or Forest Service would direct the operator to cease equipment use during the active nesting season (February 1– November 30) or as long as the nest is viable. Where feasible and consistent with NEPA, the BLM or Forest Service may relocate operations to a site greater than 0.5 mile from the condor nest site.
- Where condors occur within 1 mile of activities that include blasting, the BLM or Forest Service would require that blasting be postponed until the condors leave the area or are hazed away by personnel permitted to haze condors. Where condor nesting activity is known within 1 mile of the project area, the BLM or Forest Service would cease blasting during the active nesting season (February 1–November 30) or as long as the nest is viable. These dates may be modified based on the most current information regarding condor nesting.
- The project site would be cleaned up at the end of each day work is being conducted (e.g., trash removed, scrap materials picked up) to minimize the likelihood of condors visiting the site. BLM or Forest Service may conduct site visits to the area to ensure adequate cleanup measures are taken.

- For projects where potential exists for leakage or spill of hazardous materials, a spill plan would be developed and implemented to prevent water contamination and potential poisoning of condors. The plan would include provisions for immediate cleanup of any hazardous substance and would define how each hazardous substance would be treated in case of leakage or spill. The plan would be reviewed by the condor lead biologist to ensure that condors are adequately addressed.
- For projects where open pits or ponds are necessary, a cover or wire grid would be applied over the standing water to reduce the possibility of use by California condor and other birds.
- The BLM or Forest Service would implement the protective measures for California condors that are contained in the March 2004 *Recommended Protection Measures for Pesticide Applications in the Southwest Region of the U.S. Fish and Wildlife Service*.

MEXICAN SPOTTED OWL STANDARDS

- Surveys would be conducted of all potential spotted owl habitats, including protected, restricted, and other forest and woodland types within an analysis area plus the area 0.5 mile beyond the perimeter of the proposed mine area.

4.8.4 Bureau of Land Management Sensitive Species

Table 3.8-2 provides details of the 44 BLM Special Status species being considered in this EIS and their possible occurrence within the proposed withdrawal area. As detailed in Table 4.8-1, it was determined by agency resource specialists that a total of 10 of these plant species would not to be affected by actions proposed in this EIS. The remaining 34 species will be analyzed in more detail in the following impact discussions. BLM Sensitive species known to occur in the proposed withdrawal area include Grand Canyon rose, cliff milkvetch, Marble Canyon milkvetch, Paria Plateau fishhook cactus, Bald eagle, American peregrine falcon, northern goshawk, ferruginous hawk, golden eagle, pinyon jay, spotted bat, Allen’s lappet-browed bat, pale Townsend’s big-eared bat, Mexican long-tongued bat, Houserock Valley chisel-toothed kangaroo rat, and western burrowing owl. Species with a reasonable potential to occur within the vicinity of the proposed withdrawal area include greater western mastiff bat, Pipe springs cryptantha, Marble Canyon indigo bush, northern leopard frog, and speckled dace. Fickeisen plains cactus, paradine plains cactus, and yellow-billed cuckoo are listed and discussed as a USFWS candidate species (see Section 4.8.3).

Direct and Indirect Impacts

As previously discussed, mining associated with each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion on aquatic and terrestrial habitat impacts, see Sections 4.7.3 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels could be impacted, even small modifications to habitat could lead to potential effects on rare BLM Special Status Species. Site-specific conservation measures to avoid sensitive resources at the plan of operation at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to BLM Sensitive species.

As discussed by the USGS (Hinck et al. 2010), uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. The potential magnitude of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism.

For wildlife, the use of subterranean habitats (e.g., burrows), such as for birds, reptiles, and mammals in uranium-rich areas or reclaimed mining areas, is of particular concern in the proposed withdrawal area. These species spend a considerable amount of time in subterranean habitats where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and hibernating. The bats listed as BLM Sensitive are insectivores and could be impacted by bioaccumulation of uranium in prey items and through ingestion of water.

Impacts of Alternative A: No Action (No Withdrawal)

The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 2% of available land within that parcel being impacted. If Alternative A is implemented, approximately 2% of the available land within the North Parcel could be impacted, approximately 1.2% of available land for the East Parcel could be impacted, and approximately 0.8% of available land within South Parcel could be impacted.

Impacts to riparian habitat and water quality of surface water could impact bat and fish species known to inhabit the proposed withdrawal area. Insectivorous bat species use all habitat types found within the proposed withdrawal area and may experience collisions with vehicles if mining operations occur at night. Bats are susceptible to bioaccumulation impacts as the consume prey items. Noise associated with mining, which operates during daylight hours, will have little to no impacts to bats foraging at night since no mining operations will be active. The location of the mine facility and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influence the magnitude of impacts on these bat species. Increased uranium levels within Kanab Creek are unlikely but could have impacts to flannelmouth sucker and desert sucker, which reside in the main stem Colorado River.

The potential to impact sensitive plant species could result from physical land disturbances associated with exploration and mine sites as well as roadways and power line facilities. In addition to direct habitat impacts, indirect impacts to BLM Sensitive plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and development operations to eliminate impacts to these species consistent with applicable laws and regulations.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads will be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres could be impacted by mining. To support the exploration and development projects, approximately 6.4 miles of new roads and power lines would also be constructed. An estimated 106,225 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of the proposed withdrawal area. The North Parcel would have the most impacts, involving as much as approximately 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel could have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts to the South and East parcels to terrestrial habitats and removes the threat of uranium-related aquatic impacts affecting Colorado River species. Within the North Parcel, this alternative provides better protection to BLM Sensitive plant species than Alternative A.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated), decreased water use (64% reduction from Alternative A) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Under Alternative C, approximately 532 acres could be impacted by mining. To support the exploration and mining projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 184,065 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, involving as much as approximately 1.1% of available land within that parcel. The East Parcel could have approximately 0.6% of available land within that parcel. The South Parcel could have approximately 1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with high valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit BLM Sensitive species populations more than Alternative A but less than Alternative B, which removes the entire proposed withdrawal area from future mining claims (subject to valid existing rights).

Although the physical location of mines would not occur within Kanab Creek as part of this alternative, increased uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging bats, flannelmouth sucker, and speckled dace, which use water resources outside the proposed withdrawal area. The increase in uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and decreased water use (a 40% reduction from Alternative A) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.8%) and reduced potential for future mining near higher valued habitat, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Alternative D: Partial Withdrawal

Under Alternative D, approximately 951 acres could be impacted by mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 273,025 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would have the most impacts, involving as much as approximately 1.9% of available land within that parcel. In the East Parcel, approximately 0.6% of available land within that parcel could be impacted. The South Parcel could have approximately 0.5% of available land within that parcel impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit threatened and endangered species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat that is occupied by BLM Sensitive Species. These areas are located in the northeastern and northwestern portions of the North Parcel, where several threatened and endangered plants species occur.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%) and decreased water use (13% from Alternative A) associated with Alternative D, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

Past, present, and reasonably foreseeable mining-related activities in the proposed withdrawal area include ongoing operations at the Arizona 1 mine, as well as the current review by the BLM of a plan of operations for the EZ1, EZ2, and What deposits in the North Parcel. Potential development of these deposits is included as part of the RFD scenarios predicting reasonably foreseeable future actions (see Appendix B). Site-specific analysis, findings, and decisions regarding this plan of operations would be made by the BLM after the project-specific environmental analysis is completed, not through this EIS on the proposed mineral withdrawal. No mining-related activities are proposed for the East Parcel.

When combined with the impacts of these other activities, all of the alternatives could contribute to minor short-term and long-term direct habitat impacts, a decrease in habitat productivity, and an increase in the potential for mortality of BLM sensitive species. However, given the relatively limited surface impacts, it is anticipated none of the alternatives would result in significant cumulative impacts to BLM Sensitive species when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8.5 Forest Service Sensitive Species

Table 3.8-2 provides details of the 20 Forest Service Sensitive species being considered in this EIS and their possible occurrence within the proposed withdrawal area. All 20 Forest Service Sensitive species occur or have a reasonable potential to occur in the proposed withdrawal area, and several have been discussed in Sections 4.7 and 4.8. Forest Service Sensitive species include vascular plants, mammals, and reptile species. Mammal species comprise large herbivore, flying insectivores, and burrowing species.

Direct and Indirect Impacts

As previously discussed, mining activity under each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion on aquatic and terrestrial habitat impacts, see Sections 4.7.3 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels could be impacted, even small modifications to habitat could lead to potential effects on Forest Service Sensitive species. Site-specific conservation measures to avoid sensitive resources in the plan of operations at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to Forest Service Sensitive species.

As discussed by the USGS (Hinck et al. 2010), uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. The potential severity of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism.

For wildlife, the use of subterranean habitats (e.g., burrows), such as for the birds, reptiles and mammals in uranium-rich areas or reclaimed mining areas, is of particular concern in the proposed withdrawal area. These species spend a considerable amount of time in subterranean habitats, where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and hibernating. The bats listed as Forest Service Sensitive species are insectivorous and could be impacted by bioaccumulation of uranium in prey items and through ingestion of water.

Compliance with Environmental Regulations and Permitting

The following conservation measures had previously been developed by the Forest Service to reduce the potential for impacts to rare plants resulting from proposed uranium exploration and mining in the South Parcel. These measures would also benefit habitat for sensitive animals. The impact analysis presented below assumes compliance with the following measures:

- Vehicles would stay on designated driving routes to avoid excessive soil or vegetation disturbance.

- If warranted, the immediate impacted project area, including access roads, will be surveyed 30 days before the project begins in order to locate suitable habitat and/or populations of rare plants.
- If populations of any rare plant species are found before or during project implementation, the project proponent will coordinate with the district rare plant coordinator in order to minimize negative impacts. Individuals would be marked and avoided during project activities.
- Purchased seed or mulch will not be used within populations of rare plants, in order to prevent the introduction of invasive species and to prevent attracting wild ungulates to the area.
- Wildlife exclusionary measures such as fencing and covers or wire grids over pits and other ponded water at mine sites would further reduce potential for uranium uptake by Forest Service Sensitive animals. Increases of uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging bats.

Forest Service management standards for northern goshawk and other sensitive species are listed below. Also refer to Forest Service General Technical Report RM-217, titled “Management Recommendations for the Northern Goshawk in the Southwestern United States.” Standards state to

- Survey the management analysis area prior to habitat-modifying activities, including a 0.5-mile buffer beyond the boundary.
- Establish, and delineate on a map, a post-fledgling family area that includes six nesting areas per pair of nesting goshawks for known nest sites, old nest sites, areas where historical data indicate goshawks have nested there in the past, and areas where goshawks have been repeatedly sighted over a 2-year or greater time period but where no nest sites have been located.
- Manage for uneven-age stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer, and spruce-fir forest cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes, and species composition across the landscape. Provide foods and cover for goshawk prey.
- Limit human activity in nesting areas during the breeding season.
- Manage the ground surface layer to maintain satisfactory soil conditions, i.e., minimize soil compaction and maintain nutrient cycles.
- When activities conducted in conformance with these standards and guidelines may adversely affect other threatened, endangered, or sensitive species or may conflict with other established recovery plans or conservation agreements, consult with USFWS to resolve the conflict.
- Within the ranges of the Paradine (Kaibab) plains cactus, and the Arizona leatherflower, management activities needed for the conservation of these two species that may conflict with northern goshawk standards and guidelines will be exempt from the conflicting northern goshawk standards and guidelines until conservation strategies or recovery plans (if listed) are developed for the two species.

Impacts of Alternative A: No Action (No Withdrawal)

The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 2% of available land within that parcel being impacted. If Alternative A is implemented, approximately 2% of the available land within the North Parcel could be impacted, approximately 1.2% for the East Parcel, and approximately 0.8% of available land within South Parcel.

Impacts to riparian habitat and water quality of surface water could impact mammal species known to inhabit the proposed withdrawal area. Insectivorous bat species use all habitat types found within the proposed withdrawal area and may experience collisions with vehicles if mining operations occur at night. Mammals are susceptible to bioaccumulation impacts, as they consume prey items. The location of the mine facility and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influence the magnitude of impacts on these mammal species.

The potential to impact sensitive plant species is possible by physical land disturbances associated with exploration and mine sites as well as roadways and power line facilities. In addition to direct habitat impacts, indirect impacts to Forest Service Sensitive plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts to the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads will be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres could be impacted by mining. To support the exploration and development projects, approximately 6.4 miles of new roads and power lines would also be constructed. An estimated 106,225 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of the proposed withdrawal area. The North Parcel would likely have the most impacts, involving approximately 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel could have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts on terrestrial habitats on the South and East parcels and removes the threat of uranium-related aquatic impacts affecting Colorado River species. Within the North Parcel, this alternative provides better protection to Forest Service plant species than does Alternative A.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and decreased water use (64% reduction from Alternative A) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Under Alternative C, approximately 532 acres could be impacted by mining. To support the exploration and development projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 184,065 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would likely have the greatest amount of impacts, involving as much as approximately 1.1% of available land within that parcel. The East Parcel could have approximately 0.6% of available land within that parcel. The South Parcel could as much as approximately 1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with high valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit Forest Service Sensitive species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Although the physical location of mines would not occur within Kanab Creek as part of this alternative, increased uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging mammal species that use water resources outside the proposed withdrawal area. The increase in uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and the decreased water use (a 40% reduction from Alternative A) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.8%) and the reduced potential for future mining near higher valued habitat, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres could be impacted by mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 273,025 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would likely have the greatest amount of impacts, with as much as 1.9% of available land within that parcel impacted. In the East Parcel, approximately 0.6% of available land within that parcel could be impacted. The South Parcel could have approximately 0.5% of available land within that parcel impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit Forest Service Sensitive species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat that is occupied by Forest Service Sensitive species.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%) and decreased water use (13% from Alternative A) associated with Alternative D, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

The analysis area for Forest Service Sensitive species consists of the proposed withdrawal area (North, East, and South parcels), the Park, and North Kaibab Ranger District. When combined with the impacts of these other activities, all of the alternatives could contribute to direct habitat impacts, a decrease in habitat productivity, an increase in disturbance, and an increase in the potential for mortality of Forest Service Sensitive species.

Given the relatively limited surface impacts, it is anticipated that none of the alternatives would result in significant cumulative impacts to Forest Service Sensitive species when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8.6 National Park Service Species of Concern

Table 3.8-2 provides details of the 20 NPS Species of Concern being considered in this EIS and their possible occurrence within the proposed withdrawal area. All 20 NPS Species of Concern occur or have a reasonable potential of occurrence in the proposed withdrawal area, and several have been discussed in Sections 4.7 and 4.8. NPS Species of Concern include vascular plants, invertebrate, reptile, fish, and mammal species.

Direct and Indirect Impacts

As previously discussed, mining activity under each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion of aquatic and terrestrial habitat impacts, see Sections 4.7.3 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels is likely to be impacted, even small modifications to habitat could lead to potential effects on rare NPS Species of Concern. Site-specific conservation measures to avoid sensitive resources in the plan of operations at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to NPS Species of Concern.

As discussed by the USGS (Hinck et al. 2010), uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. The potential severity of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism.

For wildlife, the use of subterranean habitats (e.g., burrows), such as for reptiles in uranium-rich areas or reclaimed mining areas, is of particular concern in the proposed withdrawal area. These species spend a considerable amount of time in subterranean habitats, where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and hibernating. The bats listed as NPS Species of Concern are insectivorous and could be impacted by bioaccumulation of uranium in prey items and through ingestion of water.

Impacts of Alternative A: No Action (No Withdrawal)

The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 2% of available land within that parcel being impacted. If Alternative A is implemented, approximately 2% of the available land within the North Parcel could be impacted, approximately 1.2% for the East Parcel, and approximately 0.8% of available land within South Parcel.

Impacts to riparian habitat and water quality of surface water could impact mammal species known to inhabit the proposed withdrawal area. Insectivorous bat species use all habitat types found within the proposed withdrawal area and may experience collisions with vehicles if mining operations occur at night. Mammals and fish are susceptible to bioaccumulation impacts, as they consume prey items. The location of the mine facility and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influence the magnitude of impacts on these mammal species.

The potential to impact sensitive plant species could result from physical land disturbances associated with exploration and mine sites as well as roadways and power line facilities. In addition to direct habitat impacts, indirect impacts to NPS Species of Concern plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads would be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres could be impacted by mining. To support the exploration and mining projects, approximately 6.4 miles of new roads and power lines would also be constructed. An estimated 106,225 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of the proposed withdrawal area. The North Parcel would likely have the greatest amount of impacts, involving as much as approximately 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel could have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts on terrestrial habitats on the South and East parcels and removes the threat of uranium-related aquatic impacts affecting Colorado River species. Within the North Parcel, this alternative provides better protection to NPS Species of Concern plant species than does Alternative A.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and decreased water use (64% reduction from Alternative A) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Under Alternative C, approximately 532 acres could be impacted by mining. To support the exploration and development projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 184,065 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would likely have the greatest amount of impacts, involving as much as 1.1% of available land within that parcel. The East Parcel could have approximately 0.6% of available land within that parcel. The South Parcel could have approximately 1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with highly valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit NPS Species of Concern populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Although the physical location of mines would not occur within Kanab Creek as part of this alternative, increased uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging mammal species that use water resources outside the proposed withdrawal area. The increase in uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and the decreased water use (a 40% reduction from Alternative A) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.8%) and the reduced potential for future mining near higher valued habitat, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres could be impacted by mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 273,025 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would likely have the greatest amount of impacts, involving as much as approximately 1.9% of available land within that parcel. In the East Parcel, approximately 0.6% of available land within that parcel could be impacted. The South Parcel could have approximately 0.5% of available land within that parcel impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit NPS Species of Concern populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat that is occupied by Forest Service Sensitive species.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%) and decreased water use (13% from Alternative A) associated with Alternative D, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

The analysis area for NPS species of concern consists of the withdrawal area and the Park. When combined with the impacts of these other activities, all of the alternatives could contribute to potential sedimentation and contamination of drainages/waterways and springs and potential reduction in water quantity at springs in the Park.

Given the absence of direct impacts to NPS lands within the proposed withdrawal area, the limited potential for contamination and water quantity reduction, and the limited amount of foraging habitat removed, it is anticipated none of the alternatives would result in significant cumulative impacts to NPS species of concern when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8.7 Arizona Game and Fish Department Species of Greatest Conservation Need

The AGFD has statutory authority and obligation under the ARS for fish and wildlife management in the state, including the proposed withdrawal area, except within Grand Canyon National Park. This statutory obligation includes management of both game and non-game wildlife. In cooperation with the AGFD, the BLM, and Forest Service develop management plans for wildlife species and habitats (BLM 2007). Many of the management directions for wildlife included in these habitat management plans are based on statewide goals of the AGFD in managing particular species. The BLM and Forest Service management plans include construction and maintenance of habitat improvement projects, primarily water developments for big- and small-game species, but many non-game species benefit from these projects as well. The AGFD Wildlife Action Plan provides a strategic framework and information resource designed to help conserve terrestrial and aquatic wildlife and their habitats in Arizona (AGFD 2010b). The action plan focuses on habitat types, provides recommended conservation actions for each habitat type on a regional basis and develops conservation priorities for the 183 SGCN in Arizona. Included among these SGCN are 28 crustaceans and mollusks, 33 fish, 12 amphibians, 26 reptiles, 49 birds, and 35 mammals. Special attention is given to federally listed species, federal candidate species, species currently petitioned for listing, recently delisted species, and species for which Conservation Agreements already exist.

Several species listed as SGCN occur in the proposed withdrawal area, and most of these are addressed in Section 3.8 as special status species. Among the SGCN addressed in Section 3.8 are Niobrara ambersnail, Kanab ambersnail, northern leopard frog, relict leopard frog, Sonoran desert tortoise, flannelmouth sucker, humpback chub, razorback sucker, speckled dace, olive-sided flycatcher, sage thrasher, western yellow-billed cuckoo, northern goshawk, American peregrine falcon, western burrowing owl, Mexican spotted owl, southwestern willow flycatcher, California condor, bald eagle, Yuma clapper rail, desert bighorn sheep, pronghorn, southwestern river otter, Mogollon vole, Merriam’s shrew, Houserock Valley chisel-toothed kangaroo rat, black-footed ferret, greater western mastiff bat, western red bat, western yellow bat, and big free-tailed bat (AGFD 2010b). Several additional SGCN may occur on or are known to occur in the vicinity of the proposed withdrawal area. These include bluehead sucker, which occurs in Kanab Creek immediately south of the Kanab Plateau, and a variety of avian species found at higher elevations in habitats on the Kaibab Plateau (i.e., mixed conifer, spruce-fir, aspen) but not on the parcels themselves. Based on breeding distribution maps in Corman and Wise-Gervais (2005), these bird species include American three-toed woodpecker, western purple martin, red-naped sapsucker, Lewis’s woodpecker, Lincoln’s sparrow, MacGillivray’s warbler, downy woodpecker, green-tailed towhee, ruby-crowned kinglet, and golden-crowned kinglet.

As previously discussed, mining associated with each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion of aquatic and terrestrial habitat impacts, see Sections 4.7.3 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels is likely to be impacted, even small modifications to habitat could lead to potential effects on these AGFD species. Site-specific conservation measures to avoid sensitive resources in the plan of operations at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to NPS Species of Concern.

Impacts discussions in Section 4.7 and the previous discussion in this section document potential threats and impacts related to implementation of the various alternatives. The 183 species included by AGFD on the SGCN list in Arizona would mirror previous species impact discussions and alternative ranking statements. No further analysis for these AGFD species is needed.

4.9 VISUAL RESOURCES

4.9.1 Impact Assessment Methodology and Assumptions

Introduction

The visual resource impact analysis is an assessment of landscape changes that would result from potential exploration and development that may occur under the No Action Alternative (no withdrawal) or any of the withdrawal alternatives. As discussed in Chapter 3, visual resources are the combination of visible physical features that create scenery and overall landscape character. The landscape character and scenery have been analyzed and assigned a visual resource designation by the applicable land management agency (BLM, Forest Service, NPS) that denotes the area's sensitivity to changes in the landscape.

Area of Analysis

The area of analysis for visual resource impacts includes the following:

- All areas within the proposed withdrawal area and selected Key Observation Points within and outside the proposed withdrawal boundary; and
- Selected Key Observation Points within Grand Canyon National Park.

Indicators and Methods of Analysis

As discussed in Chapter 3, visual analysis involves determining whether the potential visual impacts from the proposed mineral withdrawal would meet the management objectives established for the area. Agency management objectives are applicable to this visual analysis because the process used to determine specific area objectives takes into account the visual appeal of a tract of land, public concern for scenic quality, and determining whether the tract of land is visible from travel routes or Key Observation Points. This information is used to assign a visual quality rating and management objectives to a tract of land that are subsequently used to manage and analyze activities and uses of that land.

The visual contrast rating process used for this analysis involves comparing project features with the major features in the existing landscape using the basic design elements of form, line, color, and texture. Visual impacts are the increases in line, form, color, and texture contrasts imposed on the existing landscape. These contrasts can result from surface disturbances (e.g., road and structure construction), loss of vegetation, visual intrusions (e.g., vehicles, dust, equipment), and loss of long-distance viewing caused by vehicle exhaust emissions and dust. Sound, motion, scent, rising smoke, and reflectivity can cause the attention of casual observers to be distracted by minute landscape changes. Minor impacts would be those that tend to blend into the existing landscape; major impacts would be highly visible and would not blend in with the existing landscape. This analysis describes visual impacts in general terms of meeting the federal agency VRM goals and describes potential impacts from the Key Observation Points described in Chapter 3.

The following table shows the levels of impacts and their definitions as used to assess the degree of impacts to visual resources within the proposed withdrawal area. The contrast analysis method is applied from the perspective of chosen observation points, using the terms, concepts, and visual resource objectives applicable for each federal agency. The range of effects shown below in Table 4.9-1 is a generalized, simplified range, derived from those agency classes used in preparing the analysis. The duration of impacts and definitions for this analysis are given in Table 4.9-2. The analysis below will discuss duration of impacts in terms of being temporary, short term, or long term.

Table 4.9-1. Magnitude and Degrees of Effects on Visual Resources

Attribute of Effect	Description Relative to Visual Resources
Magnitude	
No Impact	Would not produce obvious changes in landscape contrasts.
Minor	Visual impacts that would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer.
Moderate	Visual impacts that would partially retain the existing character of the landscape, and while attracting the attention of the casual viewer, would not dominate the view.
Major	Visual impacts that would create a high degree of change within the existing landscape, would dominate the view, and would be a focus of viewer attention (this will be reduced upon completion of reclamation).

Table 4.9-2. Duration Definition of Effects on Visual Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

The indicators for visual resource conditions are as follows:

- Consistency with and conformance to designated BLM VRM class objectives and Forest Service scenic quality management objectives;
- Visual contrast of anticipated activity from Key Observation Points in the proposed withdrawal area;
- Consistency with and conformance to Park visual objectives from Key Observation Points within Grand Canyon National Park.
- Visual contrast of anticipated activity from Grand Canyon National Park Key Observation Points;
- The extent to which the predicted change in regional haze attributable to mining activity is noticeable; and
- Qualitative analysis of the potential changes to the darkness of the night sky in the proposed withdrawal area and Grand Canyon National Park.

4.9.2 Impacts of Alternative A: No Action (No Withdrawal)

Changes to the Characteristic Landscape

This alternative could result in approximately 728 uranium exploration projects, 30 uranium mines, 317,505 ore haul trips, and 22.4 miles of new roads and power lines, with approximately 1,321 acres of disturbed landscape over 20 years. This could cause visual changes to the existing landscape character. Current development within the existing landscape is limited to paved state highways, minor dirt roads, power line corridors, recreation facilities, grazing facilities, and ongoing and historic mining facilities. Mineral exploration and development components that could impact visual resources are the presence of exploration drilling rigs, mine facilities (building structures, towers, and equipment), vegetation clearing, roads, power lines, ore-haul traffic, dust, and night lighting. These facilities and landscape changes could introduce new elements of form, line, color, and texture into the landscape.

During the 20-year time frame, it is expected that there could be approximately six mines in production under approved plans of operation at any one time in the entire withdrawal area. This differs from the current total of four mines with approved plans of operation (Arizona 1, Canyon Mine, Kanab North Mine, and Pinenut Mine) and only one (Arizona 1) producing uranium ore. Visual impacts depend on location and density of specific exploration and development operations and thus become project specific. Mines located in less visually sensitive areas and out of viewsheds of area visitors could have smaller impacts than mines placed in more prominent locations. Uranium mines would be located in the vicinity of uranium-bearing breccia pipe formations. This analysis discusses the typical visual impacts that could occur from exploration and development and the potential visual contrast that could be observed from Key Observation Points. It does not include specific breccia pipe locations or any speculation of potential mining locations.

The degree of impact would vary among the different stages of mining activities (mineral exploration, active mining, and mine reclamation). For example, mineral exploration generally would have a smaller visual impact than a full mining operation because of the smaller footprint size and shorter time frame. There would be more exploration projects than mines, and the total impact of all exploration projects could lead to greater visual impacts. In addition, the lands with different visual management designations have varying degrees of sensitivity to visual impacts. Mining activities that occur closer to Key Observation Points and/or in more restrictive visual management designations could have a greater visual impact than those occurring further away from the observation points and/or in less restrictive visual management designations.

Typical visual impacts that could occur from mineral exploration include vegetation disturbance of approximately 1.1 acres with a drill rig on-site for approximately 1 month. Road construction would be minimal, with use of existing roads and overland travel, and sites would be restored upon completion of the drilling project. Exploration projects out of sight of Key Observation Points and within less restrictive visual designations (VRM Classes III and IV, VQO Modification, and SMS Moderate and Low) would have a minor short-term impact. Exploration activities in the direct sight of Key Observation Points and within sensitive visual designations (VRM Class II, VQO Preservation, and SMS High) would have a moderate to major short-term impact. Major impacts could occur to persons in the direct vicinity of an exploration project during the short-term time frame if the persons are only in the area during the time at which exploration activities are occurring.

A typical breccia pipe underground mine operation would require clearing approximately 20 acres of land and re-contouring the site with berms surrounding the mine area. The mine would include various building structures for storage and personnel, containment areas created with landscape berms, heavy equipment, and a head-frame. The head-frame, constructed over the mine opening, is a steel frame structure that extends approximately 40 feet above the ground. Mining operations would represent a visual impact through changes in contrast with the characteristic landscapes form, line, color, and texture. Changes in form and line would result primarily from building structures and the head-frame structure, which stands approximately 40 feet above the ground and interrupts the natural horizon line and linear features of the landscape. This tall, vertical feature could be visible from distant viewing locations (depending on vegetation and angle of view) and become a dominant landscape feature. Vegetation removal and landscape berms would create contrast in landscape color, thus making the mine area potentially visible from distant observation points (depending on vegetation and angle of view).
The magnitude of mine operation visual impacts depends on the location of the mine relative to observation points and VRM designations. Visual impacts would be minor if the mine is located in less restrictive visual designations (VRM Classes III and IV, VQO Modification, and SMS Moderate and

Low) and not in the viewshed of an observation point. Visual impacts would range from moderate to major for a mine located in a more restrictive visual designation (VRM Class II, VQO Preservation, and SMS High) and within the viewshed of an observation point. The observation points described in Chapter 3 (including points within Grand Canyon National Park) are analyzed for potential direct and indirect effects below in Table 4.9-4.

Other visual impacts associated with mineral exploration and mining would result from new road construction, power line construction, ore-haul trucking traffic, dust, and night lighting. All of these impacts would result in landscape contrast changes through altered form, line, color, and texture. New roads would result in color and line contrast changes. Power lines could bring form and line contrasts, with vertical lines potentially visible along horizon lines.

Under Alternative A, the expected changes in visual quality described above could lead to a moderate impact to visual resources in the proposed withdrawal area, based on the parameters presented in Table 4.9-1. The degree of impact will vary, depending on the location of mining operations. Some mines may have a major impact if located in sensitive viewsheds. Other mines located in less sensitive viewsheds may have a minor impact. Uranium mines are located at uranium-bearing breccia pipes; this analysis does not identify the locations of potential mine locations.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions and are established through the agencies' (BLM's and Forest Service's) land use planning processes. The designations are used to determine the acceptable level of visual disturbance and project-specific mitigation requirements to minimize visual disturbance in order to meet the designations. The Mining Law allows for development of mining on federal lands, and may not be prohibited based on land use plan designations. However, mitigation of visual impacts from mining activities may be appropriate and will be determined during the review of the site-specific mining plan of operations.

Visual resource designations are established through a comprehensive visual data collection and analysis process and represent the visual importance and value of a particular landscape. Proposed project conformance or non-conformance with visual designations represents the general visual impact in a given area. The section below discusses each parcel's visual designation and the likelihood that each alternative's proposed management actions conform to the stated objectives.

The acreages and percentages of visual designations by alternative are presented in Table 4.9-3. This table illustrates how the range of visual designations is included in each alternative. Alternative B includes all proposed withdrawal lands and results in inclusion of 100%, or all, of the established visual resource designations. Alternative A withdraws no lands, and the acreage and percentage of visual resource designations is zero.

NORTH PARCEL

North Parcel BLM lands include VRM Classes II, III, and IV (see Figure 3.9-1, Table 3.9-4). More restrictive VRM Class I lands are located adjacent to the North Parcel. These lands, designated for preservation of the existing landscape, include the Kanab Creek Wilderness and portions of Hack Canyon area within the wilderness. The objective of VRM Class I is to provide very limited management activity, with minimal levels of change that do not attract attention of the casual viewer. It is important to note that lands within Congressionally designated (henceforth 'designated') wilderness are already withdrawn from mineral location and entry, so no mining activities would occur. Persons accessing this Class I area typically travel through the North Parcel.

VRM Class II designated lands include the Moonshine Ridge, Johnson Spring, and Kanab Creek ACECs, the Dominguez-Escalante Historic Trail corridor, and the Kanab Creek corridor Hack Canyon Trailhead area (outside the Kanab Creek Wilderness). The objective of VRM Class II is to provide for management activities that retain the existing character of the landscape. The level of change to the characteristic landscape should, therefore, be minimal. Typically, on-site evaluations and visual contrast ratings would be required prior to any mine development in Class II areas to determine appropriate mitigation measures. The probability that mine exploration and mine development occurring within Class II areas, approximately 10% of the total North Parcel, is high. Twenty-one randomly placed mines in the North Parcel could result in approximately two mines (10% of the total) being developed in the Class II area. This level of development could meet the VRM Class II objectives of minimal landscape change. However, mining operation visual impacts (described in Section 4.9.2) in high use and visually sensitive areas could be difficult to mitigate to meet the Class II objectives.

Table 4.9-3. Acreage and Percentage of Visual Designation Withdrawn by Alternative

Visual Designation	Alternative A*	Alternative B (acres)	Alternative B (%)	Alternative C (acres)	Alternative C (%)	Alternative D (acres)	Alternative D (%)
North Parcel							
Class II	0	63,208	100%	53,684	85%	33,109	52%
Class III	0	505,935	100%	316,690	62%	65,195	13%
Class IV	0	23,422	100%	12,042	51%	2,458	11%
Modification	0	3,590	100%	3,590	100%	3,590	100%
East Parcel							
Class II	0	63,296	100%	62,615	99	24,541	49%
Class III	0	50,316	100%	8,479	17	8,452	17%
Class IV	0	86	100%	86	100%	76	88%
Partial Retention	0	818	100%	818	100%	818	100%
Modification	0	30,494	100%	23,498	77%	23,498	77%
South Parcel							
High	0	25,519	100%	20,255	80%	15,191	60%
Moderate	0	283,291	100%	177,909	63%	111,199	39%
Low	0	15,621	100%	9,783	63%	7,505	48%

* Alternative A does not withdraw any acreage.

The majority of the North Parcel is designated VRM Class III, with the objective of partially retaining the existing character of the landscape. A moderate level of change from management actions within these areas is acceptable but should not dominate the view of the casual observer. Mineral exploration, development, and accompanying activities do not conflict with this designation. However, all activities would require site-specific evaluations to reduce and mitigate potential visual impacts, as appropriate.

A power line corridor along the northern border of the North Parcel and a few mineral pits are designated VRM Class IV. This designation allows for major modifications to the landscape and therefore is consistent with mine exploration and development. However, efforts to minimize visual contrast are still undertaken in VRM Class IV areas.

The North Parcel contains a small portion of Forest Service lands designated VQO Modification (see Figure 3.9-1, Table 3.9-4). The lands designated Modification are in the Kanab Creek and Snake Gulch area but outside the Kanab Creek Wilderness. Modification allows for management activities that may dominate the characteristic landscape but that must use naturally established form, line, color, and texture.

Mineral exploration, development, and accompanying activities wound not conflict with this designation with the application of project-specific visual resource mitigations.

The Kanab Creek Wilderness, adjacent to the North Parcel, is designated Preservation. Preservation allows for ecological change only and management activities that are not noticeable to observers. Mineral exploration, development, and accompanying activities conflict with this management objective. However, since the area is designated wilderness, no mining would occur.

Given the potential non-conformance with visual designation (Class II), impacts to visual resources could be moderate to major.

EAST PARCEL

East Parcel BLM lands include VRM Classes II, III and IV (see Figure 3.9-2, Table 3.9-5). The VRM Class II lands include the northern portion of House Rock Valley south of U.S. 89A and the Marble Canyon ACEC. The adjacent scenic Vermilion Cliffs contribute to the visual importance of this area. The objective of VRM Class II is to provide for management activities that retain the existing character of the landscape. The RFD scenario projects the development of two mines in the East Parcel. Nearly half of the parcel is designated VRM Class II, leading to a probability that half of the proposed mines—one—could be located in this area. This level of development could meet the VRM Class II objectives of minimal landscape change. However, mining operation visual impacts (described in Section 4.9.2) in high use and visually sensitive areas could be difficult to mitigate to meet the Class II objectives.

The VRM Class III area lies in the southern portion of House Rock Valley. Mineral exploration, development, and accompanying activities do not conflict with this designation. All activities would require site-specific evaluations to reduce and mitigate potential visual impacts.

A small portion (86 acres) of Class IV lands lies in the northeast portion of the parcel. This designation allows for major modifications to the landscape and therefore is consistent with mine exploration and development. Efforts to minimize visual contrast are undertaken in VRM Class IV areas.

The west side of the East Parcel contains Forest Service lands designated VQO Partial Retention and Modification (see Figure 3.9-2, Table 3.9-5). The Partial Retention lands are along the U.S. 89A highway corridor in the vicinity of the House Rock Valley Overlook. Partial Retention allows for management activities that may be evident to the observer but must remain subordinate to the characteristic landscape. Mineral exploration, development, and accompanying activities would likely conflict with this objective.

The lands designated Modification are on the western edge of House Rock Valley. Modification allows for management activities that may dominate the characteristic landscape but that must use naturally established form, line, color, and texture. Mineral exploration, development, and accompanying activities could meet the visual resource quality objective within this designation with the use of project-specific visual resource mitigation.

Given the potential non-conformance with visual designations (Class II, VQO Partial Retention), impacts to visual resources could be moderate to major.

SOUTH PARCEL

The South Parcel contains SMS designations of High, Moderate, and Low (see Figure 3.9-3, Table 3.9-6). High designations include Red Butte in the southern portion of the parcel and the Coconino Rim area in the northeastern portion of the parcel. High designation requires the landscape to appear unaltered and intact. Any deviations must blend so well with the existing landscape that they are not evident. Of the seven mines expected in the South Parcel, the probability of a randomly placed mine located in the area designated High (8% of total parcel) is low but possible. Mineral exploration and development impacts, as described in Section 4.9.2, would conflict with this designation, as it would not be possible to have these activities go completely unnoticed by casual observers. However, mineral exploration is a short-term impact that, when reclaimed, would not present a visual impact. Any mines located in areas designated High would result in a major visual impact.

The majority of the parcel is designated Moderate. These landscapes appear slightly altered, and any noticeable changes should remain visually subordinate to the landscape character being viewed. With site-specific design mitigations, mineral exploration, development, and associated activities would not conflict with the objectives of this designation.

A few pockets of lands designated Low are located in the South Parcel. These lands typically appear moderately altered, and deviations may begin to dominate the landscape character. Mineral exploration, development, and associated activities would not conflict with the objectives of this designation.

Given the potential non-conformance with the visual designation (SMS High), impacts to visual resources could be moderate to major.

Observation Points Direct and Indirect Impacts

Analysis of views from Key Observation Points (described in Chapter 3) is presented in the table below (Table 4.9-4). This analysis uses the indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, development, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

Table 4.9-4. Alternative A Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III. Mine operation in foreground along roadway would result in a moderate long-term impact.
Swapp Trailhead	View of VRM Class III. Mine operation in foreground would result in a moderate long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II. Mine operation in foreground and adjacent Class II areas would result in a major long-term impact. No mining would occur in Class I.
Toroweap Road Observation Point-within Antelope Canyon	View of VRM Class III. Mine operation in foreground of roadway would result in a moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in minor long-term impacts.
Big Springs Road	View of VRM Class III. Mine operation in foreground of roadway would result in a moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in minor long-term impacts.
SR 389	Limited views into the North Parcel. Views include VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.
East Parcel	
U.S. 89A	Views of VRM Class II. Mine operation in the foreground of the roadway corridor and in the Class II area would result in a major long-term impact.
U.S. 89A–Soap Creek Trailhead	Views of VRM Class II. Mine operation in the Class II area and in the foreground of the viewing location would result in a major long-term impact.
U.S. 89A–House Rock Valley Overlook	Views of VQO Partial Retention and Modification and VRM Class II. Mine operation in the foreground and background views from this location would result in a major long-term impact.
Rider Canyon Trailhead	Views of VRM Class II. Mine operation in the foreground views and the surrounding Class II area would result in a major long-term impact.
Bedrock Canyon Trailhead	Views of VRM Class III and VQO Modification. Mine operation in this area would result in a moderate long-term impact from this viewing location.

Table 4.9-4. Alternative A Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides views of SMS High and distant views of SMS Moderate and Low. Mine operation in the foreground and SMS High area would result in major long-term visual impacts.
Tusayan–SR 64	Views of SMS Moderate. Mine operation in this area would result in minor to moderate (depending on the distance from major travel corridors) long-term impacts.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Mine operation in the foreground area visible from the road would result in a moderate to major long-term impact; development in the SMS High area would result in a major long-term impact.
Forest Service Road 302	Views of SMS Moderate. Mine operation in this area would result in minor to moderate long-term impacts. The magnitude depends on distance from road.
Grand Canyon National Park and Other View Points	
Tuckup Canyon Trailhead	The GIS analysis illustrates limited views of a small portion of the North Parcel near the Park boundary, approximately 1 mile from the trailhead (Figure 4.9-1). Actual views of the North Parcel are unlikely. Views of the South Parcel at a distance of approximately 35 miles. Distant background views to this location are very limited, given vegetation and atmospheric obstructions. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is moderate.
Sowats Point	Views of the North Parcel at a distance ranging from approximately 7 to 20 miles (see Figure 4.9-1). Views consist of distant background locations. Shiny, reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Kanab Point	Views into the North Parcel are of pockets of landscape in the southern part of the parcel and an area between Grama Canyon and Kanab Creek (Figure 4.9-2). The visible area is VRM Class III. The distance is approximately 3 to 20 miles, with the visible area in the background view. Vegetative screening, distance, and landscape character would result in a minor impact to the casual observer from this location. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Havasupai Point	Views of the South and North parcels (see Figure 4.9-2). Distance from viewpoint to visible area ranges from approximately 15 to 40 miles. This distant background view would provide the casual observer very minimal chances of noticing mining and associated activities. Vegetation would likely screen and obstruct views of the North Parcel. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Cape Final	Views into House Rock Valley of the East Parcel and into the Coconino Rim area of the South Parcel (Figure 4.9-3). Distance to visible area in the South Parcel ranges from approximately 12 to 20 miles and in the East Parcel from approximately 28 to 40 miles. Impact to the casual observer, given vegetation, atmospheric obstruction, and distance, would be minimal. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Cape Royal	Views into the South Parcel from across the Grand Canyon on the North Rim that include the Coconino Rim and Red Butte (see Figure 4.9-3). Distance of views range from 10 to 25 miles, with parcel views in distant background that include pockets South Parcel of the Coconino Rim. Impact to the casual observer, given vegetation, atmospheric obstruction, and distance, would be minor. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Bright Angel Point	Views into the South Parcel from across the Grand Canyon that include Red Butte and the Coconino Rim area (Figure 4.9-4). Approximate distances of visible areas range from 10 to 25 miles. These represent background and distant views, and the likelihood of the casual observer noticing a 21-acre mine at that distance, given vegetation and atmospheric obstruction, is minimal. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Point Imperial	Views of a major portion of the East Parcel and pockets of the South Parcel, including the Coconino Rim and Red Butte (see Figure 4.9-4). Viewing distances range from approximately 20 to 35 miles. These background and distant views may provide the casual observer viewing opportunities of mine operations. However, given the distance and possible vegetation obstruction, visibility of mining is unlikely. Shiny, reflective objects on mine sites and on vehicles may be noticeable from this viewpoint. Possible views of night lighting. Impact magnitude is moderate.

Table 4.9-4. Alternative A Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other View Points, continued	
Desert View Watchtower	Views into the South Parcel of the Coconino Rim and Red Butte (Figure 4.9-5). Distances range from 5 to 20 miles. Shiny, reflective objects on mine sites and on vehicles may be noticeable from this viewpoint. Possible views of night lighting. Impact magnitude is moderate.
Grandview Point	Views into the South Parcel of the Coconino Rim area. Distances to the visible area ranges from approximately 3 to 15 miles from the viewpoint (see Figure 4.9-5). Impacts to casual observers from this viewpoint are possible, depending on vegetation obstruction. Shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible views of night lighting. Impact magnitude is moderate.
Trailview Overlook	Views of the northwestern portion of the South Parcel and Red Butte (Figure 4.9-6). Approximate distances of visible areas range from 3 to 15 miles. These represent background views. Possible views of mining operations by the casual observer. However, given vegetation obstruction and distance, they would be unlikely to notice mining operations. Shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is moderate (see Figure 4.9-6).
Hopi Point	Views of the northwestern portion of the South Parcel and Red Butte (see Figure 4.9-6). Approximate distances of visible areas range from 3 to 15 miles. These represent background views. Possible views of mining operations by the casual observer. However, given vegetation obstruction and distance, they would be unlikely to notice mining operations. Shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is moderate.

GRAND CANYON NATIONAL PARK

A viewshed analysis from Key Observation Points within Grand Canyon National Park was conducted to determine the “visible area” or “viewshed” from each viewpoint. Viewpoints analyzed include Tuckup Canyon and Sowats Point (see Figure 4.9-1), Kanab Point and Havasupai Point (see Figure 4.9-2), Cape Royal and Cape Final (see Figure 4.9-3), Bright Angel Point and Point Imperial (see Figure 4.9-4), Desert View Watchtower and Grandview Point (see Figure 4.9-5), and Trailview Overlook and Hopi Point (see Figure 4.9-6). The analysis, conducted with standard GIS viewshed methodology, uses a digital elevation model (DEM) to determine the visible area from viewpoints. Viewpoints were placed on a USGS 30-m grid DEM using locations identified on USGS 7.5-minute topographic maps and checked against known viewpoint elevations. The points were offset a minimum height of 4 m to account for potential placement error. Desert View Watchtower viewpoint was offset to meet the known land elevation and height of the tower. The GIS analysis uses algorithms to determine which grid cells can be seen from the viewpoint, based on grid cell elevation. The viewshed analysis provides information on the potential visible area from a particular location. However, it is a broad computer-generated analysis that has potential for error (viewpoint location, DEM accuracy, etc.). There could be visible areas that do not register in this analysis and areas that do show as visible do not account for any visual barriers such as vegetation, atmospheric conditions, and distance. Potential discrepancies will be noted. Site-specific analysis would be conducted for all mining proposals. Table 4.9-4 includes all of the Grand Canyon National Park viewpoints and any direct and indirect visual impacts. Impacts are determined using the criteria defined in Table 4.9-1.

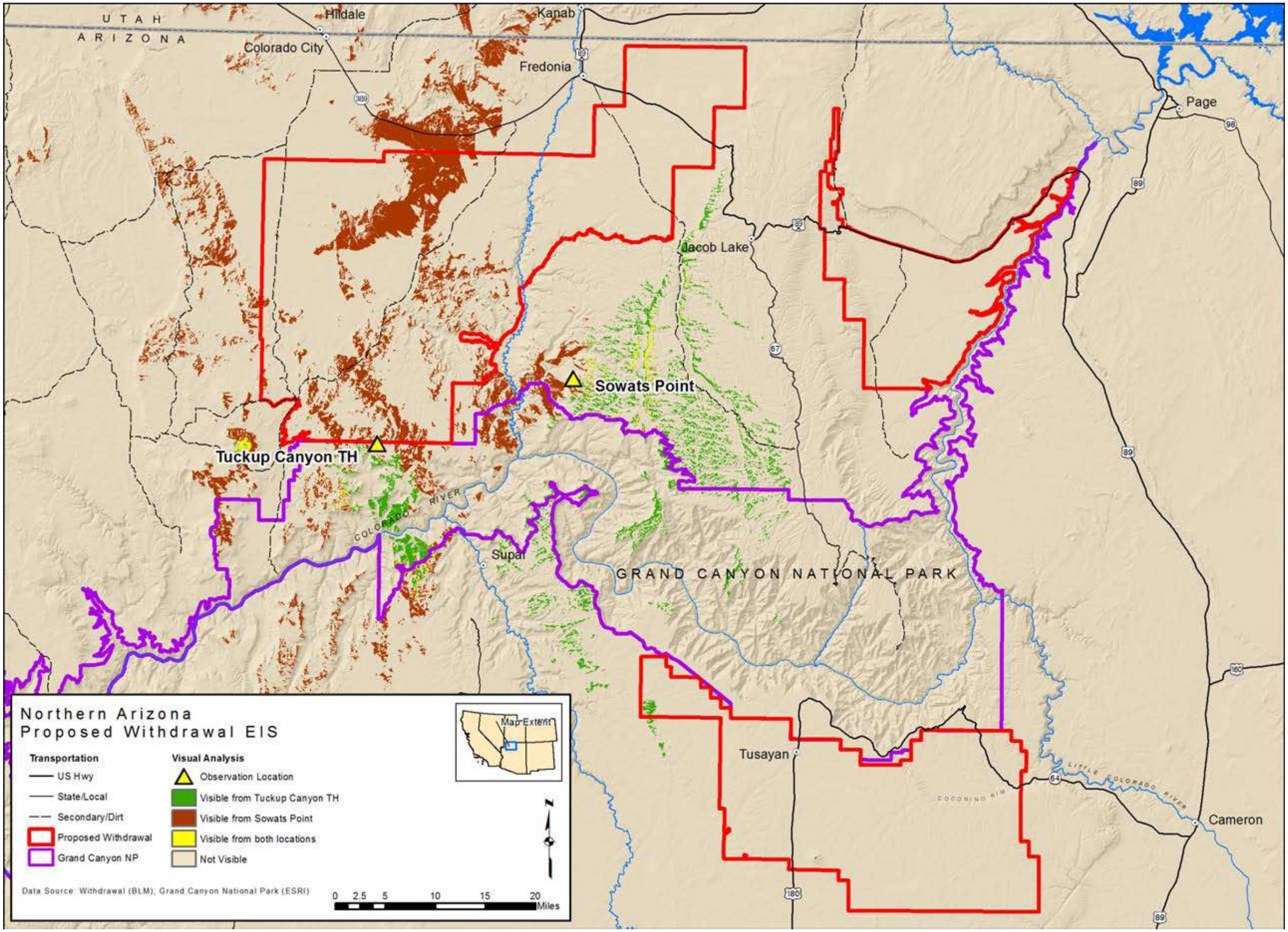

Figure 4.9-1. Viewshed analysis for Tuckup Canyon Trialhead and Sowats Point.

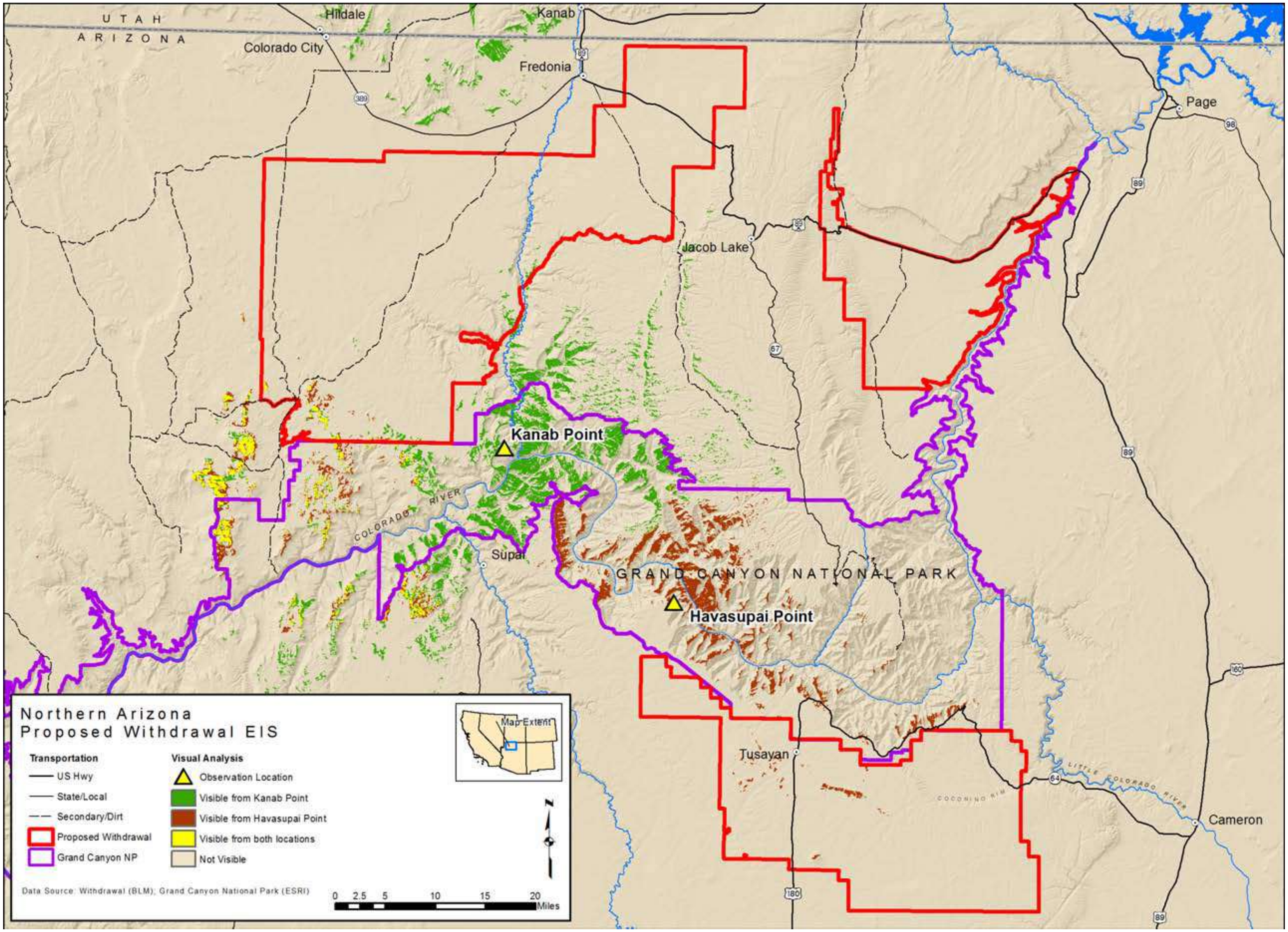

Figure 4.9-2. Viewshed analysis for Kanab Point and Havasupai Point.

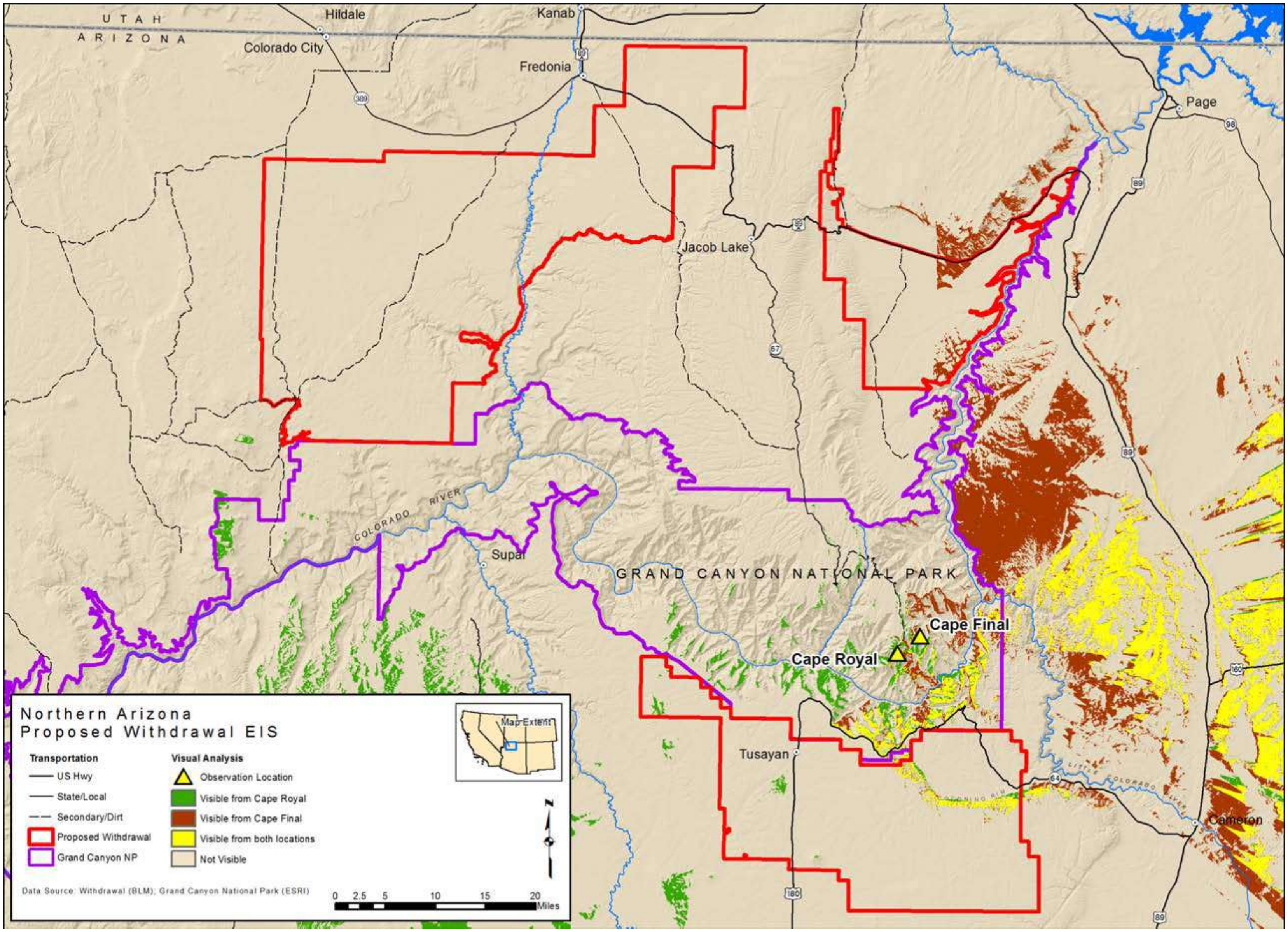

Figure 4.9-3. Viewshed analysis for Cape Final and Cape Royal.

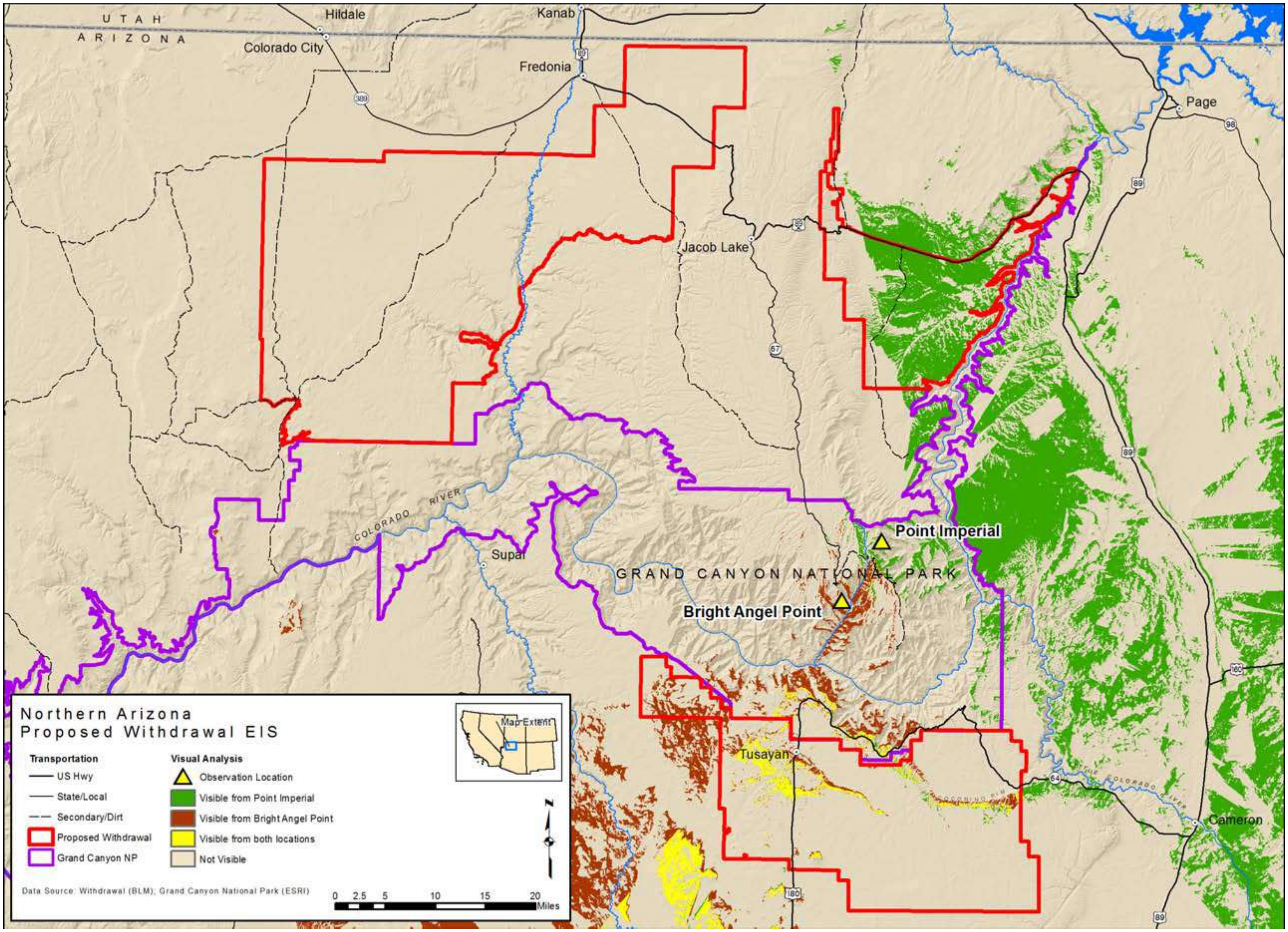

Figure 4.9-4. Viewshed analysis for Bright Angel Point and Point Imperial.

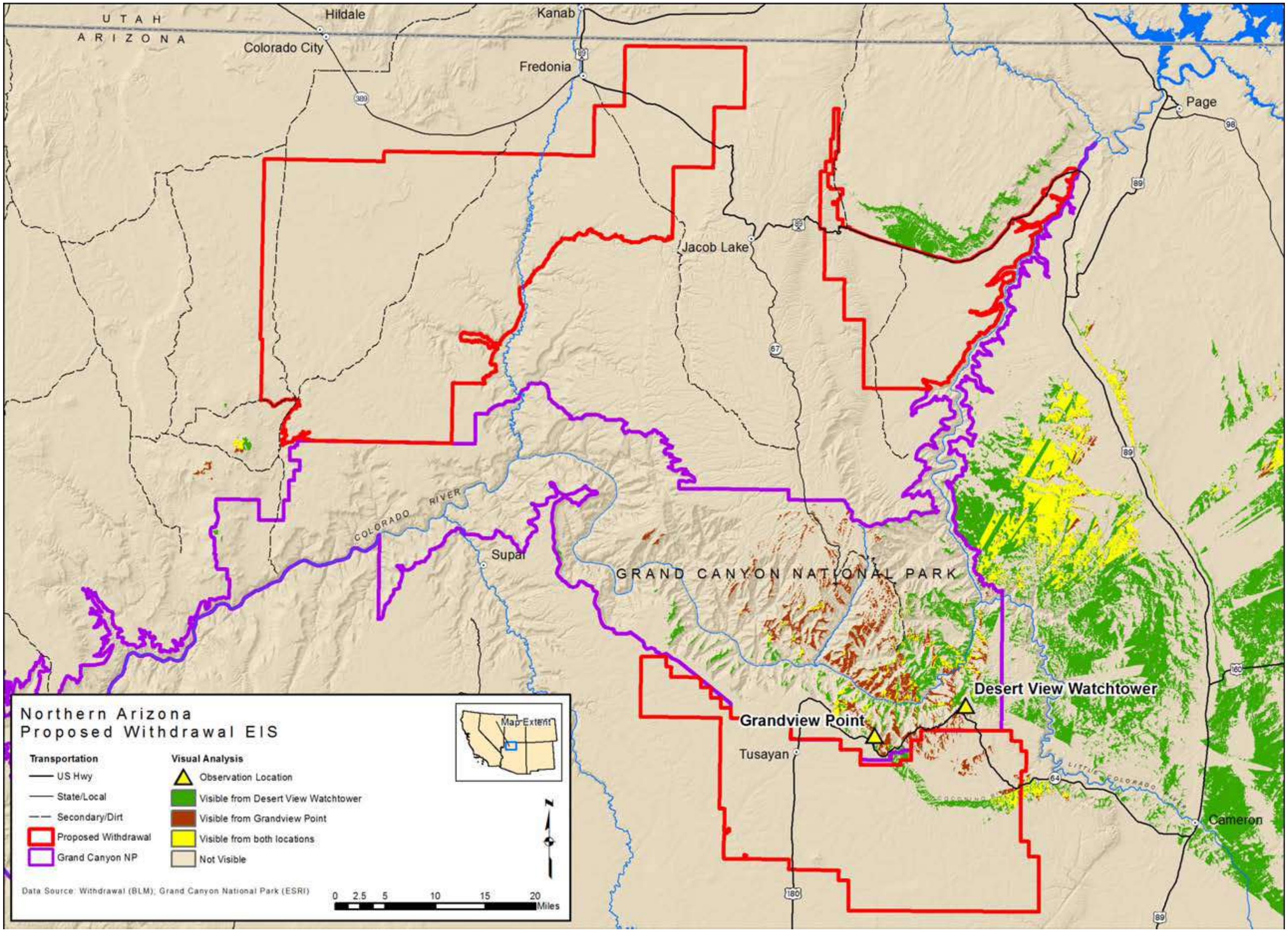

Figure 4.9-5. Viewshed analysis for Desert View Watchtower and Grandview Point.

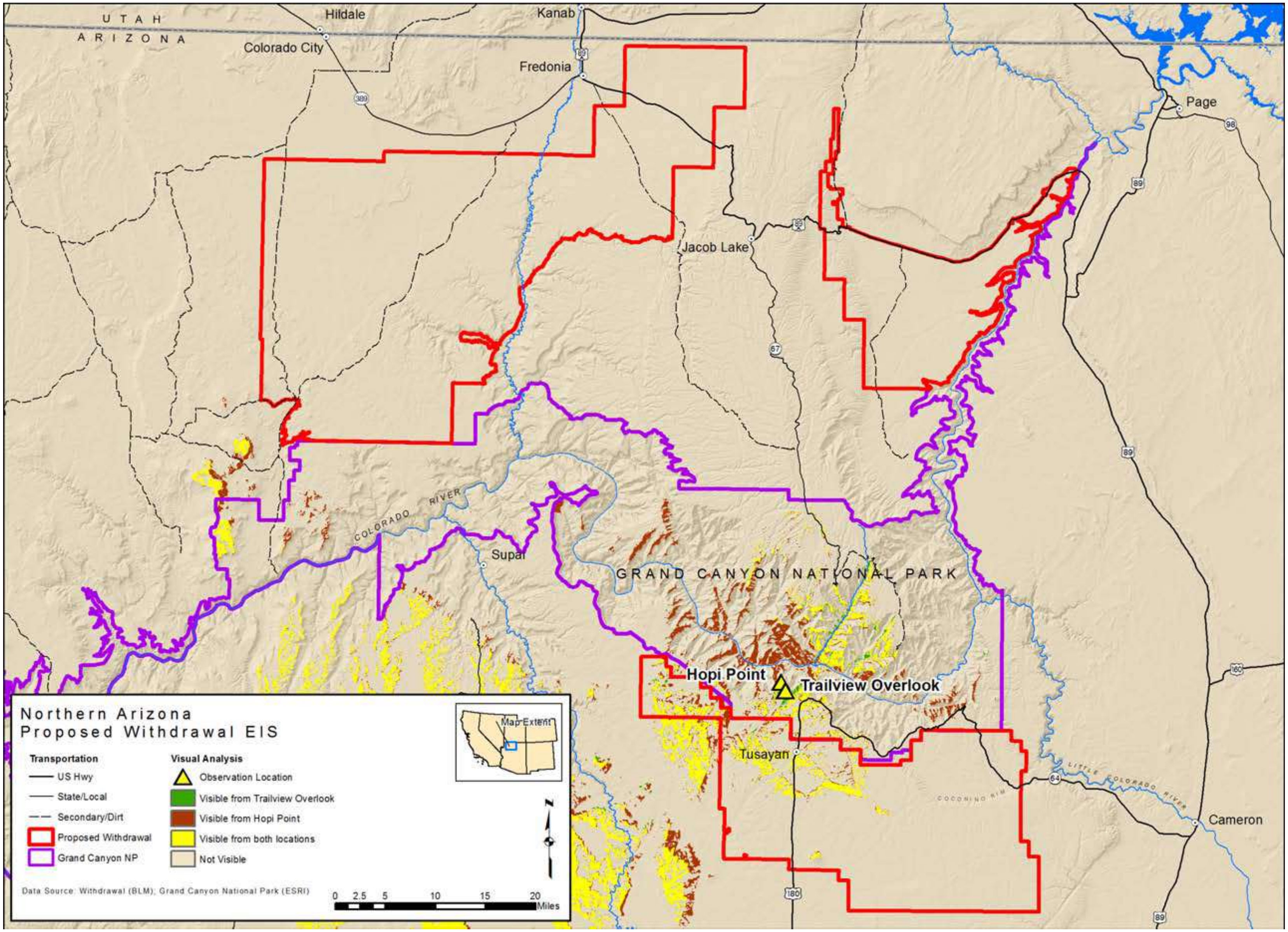

Figure 4.9-6. Viewshed analysis for Trailview Overlook and Hopi Pont.

Regional Haze and Dust

Uranium mining and associated activities would result in creation of fugitive dust. Visual impacts could result from dust emissions generated during the hauling of uranium ore to the processing facility located in Blanding, Utah. Visual impacts from truck-created dust would be localized to the unpaved roads on the haul routes. This impact depends on the frequency and density of traffic and vehicle speed and weight. Truck speed and weight directly correlate to the magnitude of dust created as slower, lighter trucks create less dust (Gillies et al. 2005). Frequent and dense truck traffic would result in visual impacts through an increase in fugitive dust. Dust impacts foreground views of persons in proximal locations. Background and long distance viewing from observation points could be impacted by an increase in dust. Localized fugitive dust generated from ore truck traffic on unpaved roads would have a visual impact on the casual observer in the vicinity of the truck traffic. Under Alternative A, these impacts would be moderate to major and long term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area and may experience major impacts.

Grand Canyon National Park is designated a Class I airshed that is protected through federal regulations and is afforded special visibility protection designed to prevent plume visual impacts to observers within the Class I area. Regional air quality modeling, described in detail in Section 4.2, Air Quality and Climate, concluded that the mining projects are expected to comply with the criteria established by the EPA for maximum protection of Grand Canyon National Park.

Night Sky

The nighttime visual resources (e.g., “dark night skies”) are an important visual resource in northern Arizona and southern Utah, as described in Chapter 3. Uranium mining and associated activities could contribute to increased light pollution in the area through lighting on mining structures, construction equipment, ore trucks, and vehicles. Given the quality of the dark night skies in the area, minimal increases in night lighting could impact the area’s night skies. Mitigation of night lighting plays an important role in protecting night skies and would be determined on a specific mining project basis. These measures could include using low visibility spectrum lights and appliances (full cut-off fixtures that emit no light above the light’s horizontal line) on mine structures, minimizing night time mining activity, and limiting ore truck travel during night hours. With mitigation, impacts to the area’s night sky would be minimal. Impacts could occur to casual observers in the vicinity of the mines and exploration sites, persons traveling along area roads at night, and recreationists camping in the area. Under Alternative A, these impacts are classified as short-term and moderate.Cumulative Effects

Cumulative effects on visual resources from Alternative A would result in relation to past, present, and future visual impacts on the landscape in the proposed withdrawal area. These cumulative visual impacts include regional light pollution from nearby communities, mechanical treatment of fire-prone vegetation (thinning, prescribed fire), noxious weed infestations, recreation amenities (trailheads, roads), livestock grazing, mining, power line corridors, unpaved roads, dust created from vehicular travel on gravel roads, and regional haze resulting from air quality impacts.

Continued population growth in large and small communities in the region of the proposed withdrawal area could erode the natural night sky conditions in the area. The night sky impacts listed above would not add to the regional light pollution and would result in no impact.

Continued treatment of fire-prone landscape vegetation through forest thinning and prescribed burning would add to the visual impacts in the proposed withdrawal area from smoke and changing the vegetative character of the landscape. Visual impacts listed above for mining and associated activities would not add cumulatively to the impact from this vegetation treatment.

There are some existing noxious weed infestations in the proposed withdrawal area. This has the potential to change existing landscape form, texture, and color over large areas. Mining and associated activities could add a minor cumulative impact to the existing noxious weed problem.

Existing recreation areas include trailheads, trails, and roads. These areas are visible forms in the landscape. Mining operations and associated activities may lead to an increase in roads and public access to areas in the proposed withdrawal area. Increased access may increase visitation and creation of new trailheads. Visual cumulative impacts of this potential increase would be minor.

Existing livestock grazing activities present ongoing visual impacts in the proposed withdrawal parcels. Visual impacts from this activity include livestock, stock tanks, dust, and altered vegetation.

The addition of 22.4 miles of new power lines and roads could lead to a moderate to minor cumulative impact (see Table 4.9-1) to visual resources, depending on the location. If the new facilities are placed in a sensitive viewing area that does not contain these features, the impact would be major. If placed in a less sensitive viewing area that currently does contain these landscape features, the cumulative impact would be minor to moderate.

The addition of 317,505 ore hauling truck trips within the proposed withdrawal area would create a major cumulative impact to visual resources. Annual vehicle traffic data from the BLM shows 9,927 trips for the Toroweap Road and 5,616 for the Clayhole Road. The combined annual total traffic count of 15,543 for the North Parcel, combined with the projected annual ore truck traffic of 10,419 trips under Alternative A, would result in a 67% potential increase in annual traffic. This increase could have a major visual cumulative impact resulting from fugitive dust generated by truck traffic. Traffic data on the other parcels' unpaved roads is unavailable.

The cumulative impact would be classified as moderate under Alternative A.

4.9.3 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Changes to the Characteristic Landscape

This alternative could result in approximately 11 uranium exploration projects, 11 uranium mines, 106,225 ore haul trips, and 6.4 miles of new roads and power lines, resulting in approximately 152 acres of disturbed landscape that would cause visual changes to the existing landscape character.

This differs from Alternative A in mining and associated activities. It represents approximate decreases by 98% in exploratory drilling, 63% in mines, 67% in ore haul trips, 71% in new roads and power lines, and 88% in disturbed land.

Typical visual impacts to the characteristic landscape from mining and associated activities are described in detail under Alternative A. This reduction in mining operations and associated activities would result in reduced visual impacts with a magnitude of minor.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions. The section below discusses each parcel's visual designation and the likelihood that the alternative's proposed management actions conform to the stated objectives. In general, conformance to visual objectives would be more likely to occur under Alternative B, given the reduction in mining and associated activities.

NORTH PARCEL

The descriptions of management designations and general determinations of conformance with visual designations remain the same as described in Alternative A; mining operations could conflict with VRM Class II management objectives. However, the substantial reduction in the number of projected mines (21 under Alternative A and 10 under Alternative B) would reduce the probability of mine operation occurrence in Class II areas by half. This leads to a probability of one mine occurring in the Class II area. Using site-specific design mitigation could make it possible to conform to the Class II designation on a case-by-case basis. One mine in the Class II area would likely result in a minor impact to visual resources.

EAST PARCEL

No mining exploration, operation, or associated activities are proposed for the East Parcel under Alternative B. This would result in conformance with all VRM objectives, as described under Alternative A. This conformance would result in no impact to visual resources.

SOUTH PARCEL

The visual resource designations and conformance details for the South Parcel are described under Alternative A in Section 4.9.2. Generally, the determinations of conformance with visual designations remain the same; mining operations conflict with SMS High management objectives. One mine is projected for the South Parcel under Alternative B. This mine is expected to be located in the existing Canyon Mine area, which is designated SMS Moderate. With applicable visual mitigation, this mine can conform to the SMS Moderate visual objectives. This likely conformance would result in minor impacts to visual resources.

Observation Points Direct and Indirect Impacts

Analysis of views from Key Observation Points (described in Chapter 3) is presented in the table below (Table 4.9-5). This analysis uses indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, development, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

Table 4.9-5. Alternative B Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground along roadway, combined with visual sensitivity, would result in a minor long-term impact.
Swapp Trailhead	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground areas, combined with visual sensitivity, would result a minor long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II (more visually sensitive). Reduced probability of mine operation in foreground and Class II areas, combined with visual sensitivity, would result in a moderate long-term impact. No mining would occur in Class I area.
Toroweap Road Observation Point–within Antelope Canyon	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in a minor long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.

Table 4.9-5. Alternative B Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel, continued	
Big Springs Road	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in a minor long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
SR 389	Limited views into the North Parcel. Views include VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.
East Parcel	
U.S. 89A	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
U.S. 89A–Soap Creek Trailhead	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
U.S. 89A–House Rock Valley Overlook	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
Rider Canyon Trailhead	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides view of SMS High and distant views of SMS Moderate and Low. Operation of the Canyon Mine (the one projected mine in the South Parcel) would result in a moderate long-term visual impact.
Tusayan–SR 64	Views of SMS Moderate. The Canyon Mine is not visible from this viewing area; mine operation would result in no visual impact.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Mine operation of the Canyon Mine would result in no visual impact.
Grand Canyon National Park and Other Viewpoints	
Tuckup Canyon Trailhead	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-1). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Sowats Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-1). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Kanab Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-2). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Havasupai Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-2). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Cape Final	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-3). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Cape Royal	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-3). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Bright Angel Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-4). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Point Imperial	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-4). However, reduction of mines and associated infrastructure under Alternative B would result in significantly less visual impact than Alternative A. Impact magnitude is minor.

Table 4.9-5. Alternative B Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other Viewpoints, continued	
Desert View Watchtower	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-5). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.
Grandview Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-5). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.
Trailview Overlook	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-6). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.
Hopi Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-6). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.

Mining activity would be greatly reduced under Alternative B. However, the projected development of 10 mines in the North Parcel may result in similar impacts to views from the analyzed observation points if any mines are located in these viewsheds. With the reduced number of mines, it becomes less likely that mining would occur in these more visually sensitive areas. The one mine projected for the South Parcel is the Canyon Mine; visual impacts are analyzed using that mine location.

Regional Haze and Dust

Potential impacts to visual resources from regional haze and dust resulting from mining operations are described in detail under Alternative A in Section 4.9.2. Reduced mining and associated activities, particularly a 67% reduction in ore haul trips, projected for Alternative B would result in reduced visual impacts from regional haze and dust. Under Alternative B visual impacts would be minor and long term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area may be experience major impacts.

Night Sky

Potential impacts to nighttime visual resources (e.g., “dark night skies”) are described in detail under Alternative A in Section 4.9.2. Reduction in projected mining and associated activities, compared with Alternative A, would result in decreased visual impacts to the night sky. Impact magnitude is minor and short term.

Cumulative Effects

Cumulative effects on the region’s visual resources are described in detail under Alternative A in Section 4.9.2. Reduction in projected mining and associated activities, compared with Alternative A, would result in reduced cumulative impacts under Alternative B. Cumulative impacts would be classified as minor.

4.9.4 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Changes to the Characteristic Landscape

This alternative could result in approximately 207 uranium exploration projects, 18 uranium mines, 184,065 ore haul trips, and 12.1 miles of new roads and power lines, resulting in approximately 508 acres of disturbed landscape that would cause visual changes to the existing landscape character.

The difference in mining and associated activities between Alternatives A and C represents approximate decreases by 71% in exploratory drilling, 40% in mines, 42% in ore haul trips, 45% in new roads and power lines, and 61% in disturbed land.

Typical visual impacts to the characteristic landscape from mining and associated activities are described in detail under Alternative A. Under Alternative C, all of the landscapes designated visually sensitive are included in the proposed withdrawal area and removed from most mining activity. Some mining would still occur in the proposed withdrawal area, as described in Alternative B, but the amount is limited. This reduction in mining operations and associated activities would result in reduced visual impacts with a magnitude of minor.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations, as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions. The section below discusses each parcel's visual designation and the likelihood for proposed management actions to conform to the stated objectives.

The acres and percentages of visual designations by alternative are presented in Table 4.9-3. This table illustrates how the range of visual designations is included in each alternative. Alternative C includes a high percentage of visually sensitive lands (Class II and High) within the proposed withdrawal boundary and thus would result in less impact to visual resources than implementation of Alternative A.

For a detailed description of visual resource designations and conformance standards for each parcel, see Section 4.9.2 under Alternative A.

NORTH PARCEL

The descriptions of management designations and general determinations of conformance with visual designations remain the same as described in Alternative A; mining operations conflict with VRM Class II management objectives. However, Alternative C has substantially less mining, compared with Alternative A, and the proposed withdrawal area under Alternative C also includes all Preservation and most Class II and High designated lands (see Table 4.9-3). Given the reduced number of mines and the limited number expected in the Class II area, it would be possible for a mine to conform to the Class II designation on a case-by-case basis. Inclusion of visually sensitive landscapes and the potential for conformance with management designation would result in a minor impact to visual resources.

EAST PARCEL

Nearly all visually sensitive areas in the East Parcel are included in the withdrawal area proposed under Alternative C (see Table 4.9-3). Ninety-nine percent of VRM Class II lands and all Partial Retention lands are included. The remaining area outside the proposed withdrawal area is less visually sensitive and designated VRM Classes III and IV and VQO Modification (see Table 4.9-2). Mineral exploration, development, and accompanying activities from one projected future mine would conform to the visual management objectives for the area outside Alternative C's withdrawal boundary. However, it is possible that development of one mine inside of the boundary (the more sensitive visual area) could not conform to the area's visual management objectives. This depends on the location of the mine and would have to be determined through site-specific analysis. This potential for one mine in the Class II area would result in a minor impact to visual resources.

SOUTH PARCEL

Almost all of the visually sensitive SMS High designated lands are included in the partial withdrawal under Alternative C (see Table 4.9-3). A small portion of the Coconino Rim area on the east side of the parcel and north of SR 64 is not included in the partial withdrawal. The remaining area is designated SMS Moderate and Low. The four projected future mine operations could be located within the area outside the withdrawal boundary and conform to existing visual management objectives and designations. Site-specific analysis on a case-by-case basis would determine ultimate compliance. Any mining located in the small portion of land designated SMS High that is out of the proposed withdrawal area would not conform to management objectives for this area. The potential for mining and associated activities occurring in visually sensitive landscapes is minimal and would result in a minor impact to visual resources.

Observation Points Direct and Indirect Impacts

Analysis of views from Key Observation Points (described in Chapter 3) is presented below in Table 4.9-6. This analysis uses the indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, development, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

Table 4.9-6. Alternative C Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III (less visually sensitive). Foreground and background views not included in this withdrawal alternative increase the probability of mine operation in foreground along roadway. This, combined with visual sensitivity, would result in a moderate long-term impact.
Swapp Trailhead	View of VRM Class III (less visually sensitive). Point is included in this withdrawal alternative. It is also in the vicinity of the reclaimed Pigeon Mine. Reduced probability of mine operation in foreground areas, because of inclusion in withdrawal, and visual sensitivity would result a minor long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II (more visually sensitive). Point is included in this withdrawal alternative. Reduced probability of mine operation in foreground and Class II areas, combined with visual sensitivity, would result in a moderate long-term impact. No mining would occur in Class I areas.
Toroweap Road Observation Point - within Antelope Canyon	View of VRM Class III (less visually sensitive). Entire road is included in this withdrawal alternative. Reduced probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in a minor long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
Big Springs Road	View of VRM Class III (less visually sensitive). Majority of road not included in this withdrawal alternative increases probability of mine operation in foreground of roadway. This, combined with visual sensitivity, would result in a moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
SR 389	Limited views into the North Parcel. Views include the less visually sensitive VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.

Table 4.9-6. Alternative C Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
East Parcel	
U.S. 89A	Views of VRM Class II (more visually sensitive). Entire corridor included in this alternative. Reduced probability of mine operation in the foreground of the roadway corridor, combined with the area's visual sensitivity, would result in a moderate long-term impact.
U.S. 89A–Soap Creek Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the Class II area and in the foreground of the viewing location would result in a moderate long-term impact.
U.S. 89A–House Rock Valley Overlook	Views of VQO Partial Retention and Modification and VRM Class II. Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground and background views from this location, combined with visual sensitivity, would result in a moderate long-term impact.
Rider Canyon Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground views and the surrounding Class II area, combined with visual sensitivity, would result in a moderate long-term impact.
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides view of SMS High and distant views of SMS Moderate and Low. Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground and SMS High area, combined with visual sensitivity, would result in moderate long-term visual impacts.
Tusayan–SR 64	Views of SMS Moderate (less visually sensitive). Entire corridor included in this withdrawal alternative. Reduced probability of mine operation in this area, combined with visual sensitivity, would result in minor long-term impacts.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Entire corridor included in this withdrawal alternative. Reduced probability of mine operation in the foreground area visible from the road, combined with visual sensitivity, would result in a moderate long-term impact.
Grand Canyon National Park and Other Viewpoints	
Tuckup Canyon Trailhead	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-1). Impact ranges from no impact to a minor impact.
Sowats Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). A majority of the visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-1). Impact ranges from no impact to a minor impact.
Kanab Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-2). Impact ranges from no impact to a minor impact.
Havasupai Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-2). Impact ranges from no impact to a minor impact.
Cape Final	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included. Nearly all visible area in the East Parcel is included (see Figure 4.9-3). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to a minor impact.
Cape Royal	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-3). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to a minor impact.
Bright Angel Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-4). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to a minor impact.
Point Imperial	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included. Approximately half of the visible area in the East Parcel is included, with the south-central portion omitted (see Figure 4.9-4). This reduces the probability of mining in the viewshed and would result in minor to a moderate impact.

Table 4.9-6. Alternative C Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other Viewpoints, continued	
Desert View Watchtower	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to a moderate impact.
Grandview Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to a moderate impact.
Trailview Overlook	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine being located in the viewshed (see Figure 4.9-6). Impact ranges from no impact to a minor impact.
Hopi Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine being located in the viewshed (see Figure 4.9-6). Impact ranges from no impact to a minor impact.

The projected development of 18 mines may result in similar impacts to views from the analyzed observation points if any mines are located in these viewsheds. With the reduced number of mines, the probability of mines being developed in visually sensitive areas is reduced. Thus, mine development visual impacts fall between Alternatives A and B.

Regional Haze and Dust

Potential impacts to visual resources from regional haze and dust resulting from mining operations are described in detail under Alternative A in Section 4.9.2. Reduced mining and associated activities, particularly a 42% reduction in ore haul trips, projected for Alternative C would result in reduced visual impacts from regional haze and dust. Under Alternative C visual impacts would be minor to moderate and long term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area and may experience major impacts.

Night Sky

Potential impacts to nighttime visual resources (e.g., “dark night skies”) are described in detail under Alternative A in Sections 4.9.2. Reduction in projected mining and associated activities as compared to Alternative A would result in decreased visual impacts to the night sky. Impact magnitude is minor and short-term.

Cumulative Effects

Cumulative effects on the region’s visual resources are described in detail under Alternative A in Section 4.9.2. Reduction in projected mining and associated activities as compared to Alternative A would result in reduced cumulative impacts under Alternative C. Cumulative effects impacts would be classified as minor.

4.9.5 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Changes to the Characteristic Landscape

This alternative could result in approximately 431 uranium exploration projects, 26 uranium mines, 273,025 ore haul trips, and 19.1 miles of new roads and power lines, resulting in approximately 914 acres of disturbed landscape that would cause visual changes to the existing landscape character.

The difference in mining and associated activities between Alternative A and Alternative D represents approximate decreases by 40% in exploratory drilling, 13% in mines, 14% in ore haul trips, 14% in new roads and power lines, and 30% in disturbed land.

Typical visual impacts to the characteristic landscape from mining and associated activities are described in detail under Alternative A. Under Alternative D, a portion of the landscapes designated visually sensitive are included in the proposed withdrawal area and removed from most mining activity. Some mining would still occur in the proposed withdrawal area as described in Alternative B, but the amount is limited. This increases the probability that mining operations and associated activities could be located in visually sensitive areas and would result in a moderate impact to visual resources.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions. The section below discusses each parcel's visual designation and the likelihood that the alternative's proposed management actions conform to the stated objectives.

The acres and percentages of visual designations by alternative are presented in Table 4.9-3. This table illustrates how the range of visual designations is included in each alternative. Alternative D includes a portion of visually sensitive lands, but leaves some visually sensitive lands outside of the proposed withdrawal boundary. This, combined with the higher number of mines, increases the likelihood of mine development in a visually sensitive area and thus increases the potential for visual impacts.

For a detailed description of visual resource designations and conformance standards for each parcel see Section 4.9.2 under Alternative A.

NORTH PARCEL

The descriptions of management designation and determinations of conformance with visual designations remain the same as described in Alternative A; mining operations may conflict with VRM Class II management objectives.

Under Alternative D, all Preservation lands are included and 52% of Class II lands in the North Parcel are included in the proposed withdrawal (see Table 4.9-3). Exclusion of half of the Class II lands, combined with the high number of mines projected for this parcel (20) increases the probability that a mine would be developed in a visually sensitive area. This would result in a moderate impact to visual resources

EAST PARCEL

Almost half of Class II lands and all Partial Retention lands are included in the proposed withdrawal area under Alternative D. The Class II lands omitted from the proposed withdrawal represent a visually sensitive area along the U.S. 89A corridor. Development of the one mine projected in this alternative on these lands would not conform to visual management objectives. The one mine projected for the East Parcel would conform to the management objectives for the Class III lands. Potential one mine developed on visually sensitive land would result in a minor impact to visual resources.

SOUTH PARCEL

Alternative D includes 60% of the visually sensitive SMS High designation in the proposed withdrawal. This increases the probability that a mine would be developed in this visually sensitive area and increases the potential visual impacts in the area. The area not included in the proposed withdrawal includes the Red Butte area and a portion of the Coconino Rim. Mine development in the area of this designation would not conform to the area's management objectives. This would result in a moderate impact to visual resources.

Observation Points Direct and Indirect Impacts

Analysis of views from key observation points (described in Chapter 3) is presented below in Table 4.9-7. This analysis uses the indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, mining, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

Mining activity is minimally reduced under Alternative D relative to Alternative A and a portion of visually sensitive landscapes are included in the proposed withdrawal area. The projected development of 26 mines would likely result in similar impacts to views from the analyzed observation points if any mines are located in these viewsheds. Given the omission of visually sensitive lands and the high number of mines the probability of mine development in visually sensitive areas is higher under this alternative than under Alternatives B or C.

Regional Haze and Dust

Potential impacts to visual resources from regional haze and dust resulting from mining operations are described in detail under Alternative A in Section 4.9.2. Reduction in mining and associated activities, particularly a 14% reduction in ore haul trips, projected for Alternative D would result in reduced visual impacts from regional haze and dust. Under Alternative D visual impacts would be moderate and long term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area may be experience major impacts.

Night Sky

Potential impacts to nighttime visual resources (e.g., "dark night skies") are described in detail under Alternative A in Sections 4.9.2. There is some reduction in projected mining and associated activities, compared with Alternative A, that would result in some decreased visual impacts to the night sky. Impact magnitude is moderate and short term.

Cumulative Effects

Cumulative effects on the region's visual resources are described in detail under Alternative A in Section 4.9.2. Some reduction in projected mining and associated activities, compared with Alternative A, would result in minor reduced cumulative impacts under Alternative B. Cumulative impacts would be classified as moderate.

Table 4.9-7. Alternative D Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III (less visually sensitive). Foreground and background views not included in this withdrawal alternative increase the probability of mine operation in foreground along roadway. This, combined with visual sensitivity, would result in moderate long-term impact
Swapp Trailhead	View of VRM Class III (less visually sensitive). Point not included in this withdrawal alternative. Increased probability of mine operation in foreground areas, combined with visual sensitivity, would result moderate long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in foreground and Class II areas, combined with visual sensitivity, would result in moderate long-term impact. No mining would occur in the Class I area.
Toroweap Road Observation Point - within Antelope Canyon	View of VRM Class III (less visually sensitive). Nearly the entire corridor is not included in this withdrawal alternative. Increase probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
Big Springs Road	View of VRM Class III (less visually sensitive). Entire corridor not included in this withdrawal alternative. Increased probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
SR 389	Limited views into the North Parcel. Views include VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.
East Parcel	
U.S. 89A	Views of VRM Class II (more visually sensitive). Over 50% of this corridor is not included in this withdrawal alternative. Increased probability of mine operation in the foreground of the roadway corridor and in the Class II area would result in a major long-term impact.
U.S. 89A–Soap Creek Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the Class II area and in the foreground of the viewing location would result in a moderate long-term impact.
U.S. 89A–House Rock Valley Overlook	Views of VQO Partial Retention and Modification and VRM Class II. Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground and background views. However, views from this point include a large portion of the House Rock Valley that is not included in the withdrawal in this alternative. Any mining visible from this location would result in major long-term impact.
Rider Canyon Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground views and the surrounding Class II area would result in moderate long-term impact.
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides view of SMS High and distant views of SMS Moderate and Low. Point not included in this withdrawal alternative. Increased probability of mine operation in the foreground and SMS High area would result in major long-term visual impacts.
Tusayan–SR 64	Views of SMS Moderate (less visually sensitive). Majority of corridor not included in this withdrawal alternative. Increased probability of mine operation in this area, combined with visual sensitivity, would result in minor to moderate long-term impacts.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Corridor included in this withdrawal alternative. Reduced probability of mine operation in the foreground area visible from the road would result in moderate long-term impact.
Grand Canyon National Park and Other View Points	
Tuckup Canyon Trailhead	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine being located in the viewshed (see Figure 4.9-1). Impact ranges from no impact to minor impact.

Table 4.9-7. Alternative D Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other View Points, continued	
Sowats Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). A majority of the visible area visible area is not included in this withdrawal alternative; the visible area closest to the point is included (see Figure 4.9-1). The probability of a mining in the excluded portions is increased. Impact magnitude is minor.
Kanab Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas from this point are included in this withdrawal alternative (Kanab Creek area). The visible area in the southern portion of the North Parcel is not included (see Figure 4.9-2). Impact magnitude is minor.
Havasupai Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas in the South Parcel are included in this withdrawal alternative. Visible areas in the North Parcel are not included (see Figure 4.9-2). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor.
Cape Final	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included. The northern visible area in the East Parcel is not included; the southern area is (see Figure 4.9-3). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor.
Cape Royal	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-3). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to minor impact.
Bright Angel Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas in the South Parcel are included in this withdrawal alternative. Visible areas not included consist of Red Butte, the area near the eastern portion of Highway 64, and a small portion of the Coconino Rim area (see Figure 4.9-4). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor.
Point Imperial	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas in the South Parcel are included in this withdrawal alternative. Visible areas not included consist of Red Butte, the area near the eastern portion of Highway 64, and a small portion of the Coconino Rim area (see Figure 4.9-4). Approximately 25% of the visible area in the East Parcel (the eastern portion) is included. The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor to moderate.
Desert View Watchtower	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to moderate impact.
Grandview Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to moderate impact.
Trailview Overlook	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas from this point are included in this withdrawal alternative. Areas omitted include Red Butte and the area near the eastern portion of Highway 64 (see Figure 4.9-6). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor to moderate.
Hopi Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas from this point are included in this withdrawal alternative. Areas omitted include Red Butte and the area near the eastern portion of Highway 64 (see Figure 4.9-6). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor to moderate.

4.10 SOUNDSCAPES

4.10.1 Introduction

This section describes the potential noise impacts associated with each alternative being evaluated for this EIS. The soundscape condition indicators that are evaluated in this analysis include the following:

1. Sound pressure levels produced by exploration and mining equipment and the distance from the source before noise levels are attenuated to background levels.
2. Areas in which the measured noise levels would exceed the ambient conditions because of noise associated with the proposed or alternative actions.
3. Analysis of the effects to the natural soundscape within Grand Canyon National Park as defined in Section 4.9 of the 2006 NPS Management Policies (NPS 2006b).
4. Comparison with the rules, policies, or orders established by the federal land managers and the EPA.

The EPA has published acoustical guidelines designed to protect the public health and welfare with an adequate margin of safety. The EPA has determined that an Ldn of 55 dBA protects the public from indoor and outdoor activity noise interference. An Ldn of 55 dBA is equivalent to a continuous noise level of 48.6 dBA.

Title 36, Parks, Forests, and Public Property, Part 2.12, Audio Disturbances, states that “operating motorized equipment or machinery that exceeds a noise level of 60 dBA at 50 feet or, if below that level, makes noise, which is unreasonable, considering the nature and purpose, location, time of day or night, purpose for which the area was established, impact on park users, and other factors that should govern the conduct of a reasonably prudent person under the circumstances” [36 CFR 2.12].

NPS Director’s Order 47, Soundscape Preservation and Noise Management, requires the natural soundscape to be protected, maintained, or restored to a condition unimpaired by inappropriate or excessive noise. In accordance with Section 4.9 of the NPS (2006b) Management Policies, “The Service will take action to prevent or minimize all noise that through frequency, magnitude, or duration adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified through monitoring as being acceptable to or appropriate for visitor uses at the sites being monitored.” Given the proximity of the proposed withdrawal area to the Park, consideration should be given to natural soundscapes, wildlife, cultural landscapes, wilderness character, and the visitor experience.

The 2003 Coconino County Comprehensive Plan stresses the desire for natural quiet as a community characteristic. While the plan sets no specific levels of acceptable noise, it does state that “noise should be considered when reviewing plans for new commercial and industrial developments especially those located close to residential, open space, or recreation areas.”

This assessment of noise impacts required the identification of mining-related noise sources and the location of noise-sensitive receptors. Acoustical calculations were performed to estimate the noise levels as a result of exploration, development, and mine operation. Impacts were based on the project’s compliance with applicable noise safety requirements and in relation to Park values, including the ambient noise level (soundscapes), wildlife, cultural landscapes, wilderness character, and visitor experience.

As mentioned in Section 3.10, each of the proposed withdrawal parcels borders the Park. Natural ambient sound levels in non-tourist areas of the park are generally low level, ranging from 18.3 to 22.8 dBA, with a log mean sound level of 20.8 dBA (Ambrose 2010a). The ambient noise level used for natural soundscapes in this study is 20.8 dBA.

Ambient noise levels can be affected by the exploration, development, and operation of the projected mining projects. The magnitude and frequency of this noise may vary considerably over the course of the day, throughout the week, and across the varying seasons, in part as a result of the project schedule, the changing weather conditions, and the effects of seasonal vegetation cover.

Wind can further reduce the sound heard at a distance if the receptor is upwind of the sound. The action of the wind disperses the sound waves reducing the sound pressure levels upwind. While it is true that sound levels upwind of a noise source will be reduced, receptors downwind of a noise source will not realize an increase in sound level over that experienced at the same distance without a wind. This dispels the common belief that sound levels are increased downwind as a result of wind carrying noise.

The reflection, refraction, scattering, and absorption effects resulting from any obstruction (barriers, ground, vegetation, trees, hills, etc.) between a noise source and the receiver likely result in excess attenuation (Fang and Ling 2003). The Federal Highway Administration (1998:17) attributes approximately 1 to 3 dB of noise reduction for every 100 feet of vegetation that is “sufficiently dense to completely block the view along the sound propagation path.”

4.10.2 Incomplete or Unavailable Information

The on-the-ground sound study titled *Sound Levels of Equipment and Operations at the Arizona I Uranium Mine in Northern Arizona, March 20, 2010 to April 8, 2010* (Ambrose 2010b), dated June 21, 2010, provides data that can be used for modeling attenuation rates and audibility distances. However, refined modeling was not conducted for this EIS. Such modeling is required to estimate potential impacts to the natural soundscape of the Park.

A valid analysis of attenuation potential of any obstruction cannot be made without an exact description of factors characterizing the noise source, and receiver. Conditions such as the height, the placement of source (relative to any obstruction), the spectrum of the source and its duration (steady or transient), the size and density of vegetation, and the atmospheric conditions (temperature, wind gradient, relative humidity, and cloud cover). Without knowledge of the specific location of each noise source, these variables cannot be considered.

While there is a large body of peer-reviewed literature available regarding the effects of noise on wildlife, this EIS is framed as an overarching review for a very large area included in the three parcels, and no substantive evaluation of noise effects on wildlife can be generically applied. If a future mine were proposed, a separate environmental analysis for that specific location would be performed at a level of detail appropriate for that site in a manner that ensures land use conditions that would be protective of the environment for that location.

Similarly, there have been numerous studies regarding the effects of aircraft noise on natural quiet conditions in the Park. However, without knowledge of the type and number of specific aircraft that would be used for aerial prospecting or the location and durations of such prospecting, an accurate estimate of impacts is difficult.

4.10.3 Impact Assessment Methodology and Assumptions

To assess the current value of the resource condition indicators, measurement of existing background noise levels in the specific area of any potential mine sites would be required. Once the background values are accurately established, screening level noise models could be run using either measured or manufacturer noise data from proposed mining equipment consistent with the proposed mining operations. The results of the model would allow for a mathematically sound estimate of possible noise effects of proposed mining operations at virtually any remote receiver of interest as agreed to by the concerned parties. Without specific knowledge of the location of potential mine sites, no realistic conclusions can be drawn with regard to the possible noise effects of their operation on the Park or any other nearby receiver of concern. Tables 4.10-1 and 4.10-2 provide definitions of impact magnitude and duration, respectively, as they relate to soundscapes.

Sound levels of mining equipment and operations were measured at the Arizona 1 Uranium Mine between March 20 and April 8, 2010. Monitors were placed approximately 492 feet west of the mine and approximately 466 feet from BLM Road 1058 (7,874 feet southwest of the mine sound monitor). The distance from each noise source was measured, and the sound levels at 50 feet were calculated.

The sound levels of common sources at Arizona 1 Mine and on BLM Road 1058 are presented in Table 4.10-3.

Table 4.10-1. Magnitude and Degrees of Effects on Soundscapes

Attribute of Effect	Description Relative to Soundscapes
Magnitude	
No Impact	Would not produce obvious changes in baseline condition of the resources.
Minor	Impacts would occur, but resources would retain existing character and overall baseline conditions.
Moderate	Impacts would occur, but resources would partially retain existing character. Some baseline conditions would remain unchanged.
Major	Impacts would occur that would create a high degree of change within the existing resource character and overall condition of resources.

Table 4.10-2. Duration Definition of Effects on Soundscapes

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

The noise levels in Table 4.10-3 were measured using the dBA scale to reflect the acuity of the human ear, which does not respond equally to all frequencies. The dBA scale specifically places a preference or “weighting” on sound frequencies that approximate the human ear’s response to low-level sound. Additionally, this weighting preference in the frequency range from approximately 1,000 to 5,000 hertz targets the frequencies most common for human speech and is therefore an indicator of possible impediments to communication.

Typically, the human ear’s minimum threshold of perception for changes in noise levels is considered to be 3 dBA. A change in noise level of 6 dBA is clearly noticeable to the human ear, while an increase of

10 dBA is perceived as a doubling of the noise level. A perceived doubling of the noise level would be the physical equivalent of halving the distance between the noise source and receiver. Based on the perception of sound, impacts from increased sound levels in the range of 3 to 6 dBA would be noticeable.

Table 4.10-3. Noise Levels (dBA) for Equipment Used at the Arizona 1 Mine (at 15 m)

Sound Source	dBA at known distance from source (measured)	Distance (feet) from source (measured)	dBA at 50 feet (calculated)
Vent Fan	60	400	78
Trucks Traveling ~25 mph	59	466	77
Ore Dumping on Surface	58	551	76
Trucks Arriving to Site	55	551	73
Front-end Loader w/ Backup Horn	51	551	69
Ore Bucket (Vertical Shaft Movement)	36	551	54
Electric Transformer	27	394	45

Source: Ambrose (2010b).

It is important to remember the decibel scale is logarithmic. Therefore, the combined sound level of several sources is not derived by simply adding the decibels together. For example, 10 sources producing 70 dBA at 50 feet will have the combined sound pressure level of 80 dBA, not 700 dBA. The following formula is used to calculate the total sound pressure level of multiple sources:

$$\text{Total L} = 10 \times \log_{10}\left(\sum_{1}^{n} 10^{\frac{L_n}{10}}\right)$$

Where: Total L = Combined sound pressure level

L = Individual sound pressure level

n = number of sources

The application of this formula cannot account for the relative position of the sources.

A general roster of commonly used equipment during typical construction operations was used in this assessment. Denison provided a list of equipment used at the Arizona 1 Mine site that should be considered typical of equipment that would be used at other mines in the area (personal communication, Lorraine Christian, BLM 2010a). The equipment in use at the Arizona 1 Mine site includes the following:

- 40-ton haul trucks (loaded with 25 tons of ore)
- Two front-end loaders with 2.5- to 3.5-yard buckets
- One water truck
- One forklift
- One vent fan
- One sorting screen
- One emergency generator

Table 4.10-4 presents the typical noise emissions levels at 50 feet for the noise-producing equipment that would potentially be used during exploration and development activities. *Predicting the Sound Level at Distances Greater than 100 Meters for Outdoors Sound Propagation*, Version 1.1, from Associates in Acoustics, Inc., was used to estimate the distance from the source to achieve attenuation to 20.8 dBA.

Table 4.10-4. Noise from Typical Mining Equipment Activities during Exploration, Development, and Reclamation/Closure

Primary Equipment	Estimated Maximum Sound Pressure Level (L_{max}) at 50 feet*	Number of Devices	Estimated Combined Noise Level (dBA) at the Specified Distance of 50 feet[†]	Estimated Distance from the Source to achieve attenuation to 20.8 dBA[‡] (feet)
Exploratory Activity (per site)				
Truck, Pick-Up	75	4	81	7,740
Water Truck	83	1	83	8,730
Drill Rig (Travel)	79	1	79	6,860
Drill Rig (Drilling)	86	1	86	10,400
Mine Development (per mine site)				
Truck, Pick-Up	75	10	85	9,810
Back Hoe, w/Bucket	78	1	78	6,430
Crane, Hydraulic, 25–35 Ton	83	1	83	8,730
Loader, Front End, w/ Bucket	80	1	80	7,300
Road Grader	85	1	85	9,810
Truck, Dump, 10 Ton	76	1	76	5,680
Truck, Flatbed, 2 Ton	74	2	77	6,040
Water Truck	83	1	83	8,730
Generator	81	1	81	7,740
Truck, Semi, Tractor	86	2	89	12,240
Mine Development (per mile of new access road)				
Backhoe / Front Loader	80	1	80	7,300
Road Grader	85	1	85	9,810
Scraper	84	1	84	9,280
Dozer	82	1	82	8,230
Truck, Pick-Up	75	5	78	6,430
Truck, Semi, Tractor	86	2	89	12,240
Water Truck	83	1	83	8,730
Mine Development (per mile of new power line)				
Truck, Pick-Up	75	5	82	8,230
Back Hoe, w/Bucket	78	1	78	6,430
Digger, Distribution, Truck Mount	85	1	85	9,810
Crane, Hydraulic, 25–35 Ton	81	2	84	9,280
Backhoe / Front Loader	76	1	76	5,680
Forklift, 5 Ton	73	1	73	4,630
Truck, Flatbed, w/ Bucket, 5 Ton	74	2	77	6,040
Truck, Dump, 10 Ton	76	1	76	5,680
Truck, Wire Puller, 3-Drum	84	1	84	9,280
Roller/Compactor	80	1	80	7,300
Water Truck	83	1	83	8,730
Truck, Semi, Tractor	86	2	89	12,240

Table 4.10-4. Noise from Typical Mining Equipment Activities during Exploration, Development, and Reclamation/Closure (Continued)

Primary Equipment	Estimated Maximum Sound Pressure Level (L_{max}) at 50 feet*	Number of Devices	Estimated Combined Noise Level (dBA) at the Specified Distance of 50 feet†	Estimated Distance from the Source to achieve attenuation to 20.8 dBA‡ (feet)
Mine Closure and Reclamation (per site)				
Road Grader	85	1	85	9,810
Truck, Pick-Up	75	5	82	8,230
Water Truck	83	1	83	8,730
Truck, Semi, Tractor	86	2	89	12,240

Source: Federal Highway Administration (2006).

* Sound levels for construction equipment were obtained from Federal Highway Administration (2006) and equipment manufacturer specifications.

† Derived by adding the sound pressure levels logarithmically using the formula $Leq_{total} = 10 \log(\Sigma Leq/10)$.

‡ Estimated distance from the source to achieve attenuation to 20.8 dBA was calculated using Associates in Acoustics, Inc. (2002).

The maximum sound pressure levels (L_{max}) levels listed on this table should not be compared directly with the recommended L_{dn}. Day-night average levels are only valid for a 24-hour period and are computed as a 24-hour time weighted average with specific stipulations regarding the hours between 10:00 pm and 7:00 am. The concept is based on the premise that people are more annoyed by a given level of noise during typical sleeping hours.

While the operation of multiple mine sites within a single parcel would have additive effects on the noise levels at certain receptors, the distances between the operations, alignment of the activities relative to the receptor of concern, and the specific equipment used for each operation would need to be considered prior to attempting to model potential noise levels. Should future mining operations be proposed, the noise affects of the individual operations would be considered, and all subsequent proposed operations would be evaluated for the specific site’s potential additive effects to the local soundscapes.

Noise levels from exploration, mine development, and reclamation/closure activities may occur near an NSA. A portion of each proposed withdrawal area borders the Park. Therefore, there is the potential for sounds from the mine exploration, development, and reclamation/closure activities to be audible within the Park.

Operation of the underground mines could increase the ambient noise levels in the immediate vicinity of the mine sites and haul roads. The primary noise sources at a typical underground mine site include operation of heavy-duty diesel equipment (e.g., drill rigs, water trucks, graders, dump trucks, front-end loaders, ore haul trucks, etc.) and stationary mining equipment (e.g., mine shaft vent fans and sorting screens). The overall noise level generated by the equipment depends on where the equipment is being used, the number of individual equipment units, and the mitigation measures employed. Table 4.10-5 presents the typical noise emissions levels at 50 feet for the noise-producing equipment that would be used during operation of the mine. Additionally, the table provides the estimated distance from the source to achieve attenuation to 20.8 dBA is provided.

Each of the proposed withdrawal parcels borders the Park. Table 4.10-6 presents the potentially impacted area of the Park, the percentage of the area of the Park, and the approximate dBA range of mining operation noise levels for three varying distances from the withdrawal parcels for all of the Park area and for the area above the Grand Canyon rim. The noise levels included in the table below are provided for illustration; each proposed mine operation would require individual analysis to estimate the possible effects of noise from that specific location, relative to the location of receptors of concern.

Table 4.10-5. Noise from Typical Mining Equipment Activities during Operation

Primary Equipment	Estimated Maximum Sound Pressure Level (L_{max}) 50 feet*	Number of Devices	Estimated Combined Noise Level (dBA) at the Specified Distance of 50 feet†	Estimated Distance from the Source to achieve attenuation to 20.8 dBA‡ (feet)
Mine Operation (per site)				
Truck, Pick-Up	73	5	76	5,680
Backhoe / Front Loader	69	2	72	4,330
Ore Dumping	76	12	79	6,860
Mineshaft Vent Fan	78	2	81	7,740
Transformer	45	1	45	2,200
Haul Trucks				
Trucks Traveling ~25 mph	77	1	77	7,280

Source: Federal Highway Administration (2006).

* Sound levels for construction equipment were obtained from Ambrose (2010b), Federal Highway Administration (2006), and equipment manufacturer specifications.

† Derived by adding the sound pressure levels logarithmically using the formula $Leq_{total} = 10 \log(\Sigma Leq/10)$.

‡ Estimated distance from the source to achieve attenuation to 20.8 dBA was calculated using Associates in Acoustics, Inc. (2002).

Table 4.10-6. Percentage of Grand Canyon National Park Mean Mining Operation Sound Levels from Various Distances from Withdrawal Area

Distance from Withdrawal Area	Number of Acres	Percentage of Grand Canyon National Park	Mining Operations Mean dBA, Range
All of Park Areas			
Within 7.5 km	219,940	18%	87.3–33.3
Within 15 km	469,566	39%	33.3–27.3
Within 30 km	867,398	72%	27.3–21.3
Above the Canyon Rim			
Within 7.5 km	106,998	9%	87.3–33.3
Within 15 km	139,082	12%	33.3–27.3
Within 30 km	249,637	21%	27.3–21.3

Source: Ambrose (2010a).

Note: Natural ambient sound levels in non-tourist areas of the Park have been measured to range from 18.3 to 22.8 dBA, with a log mean sound level of 20.8 dBA (Ambrose 2010a).

Noise levels from mining equipment operation could contribute noise within the area of the mine site. Under ideal meteorological, geographic, and terrestrial conditions, the noise impacts could extend a considerable distance from the source. Therefore, the large increase in operational noise within the immediate vicinity of the mine operations represents a change to the ambient environment and has the potential to add sound energy to the local environment. Furthermore, since the proposed withdrawal parcels border the Park, it is possible that sounds from the mine operation activities could be audible within the Park. However, this is relative to the location of the actual source within the parcel and must be determined for each source location.

Outside the boundaries of the proposed withdrawal area, ore haul trucks could have localized, short-term, transient impacts on residences and communities adjacent to the paved highways used by the haul trucks traveling from the mine sites to the ore processing facility in Blanding, Utah. Traffic volume, speed, and vehicle type all affect noise levels. One truck traveling at 55 mph will sound as loud as 28 cars moving at the same speed (Federal Highway Administration 2010). Typical noise levels for heavy trucks (e.g., log-haul tractor-trailers (semi-trucks), large tow trucks, dump trucks, cement mixers, large transit buses, motor homes with exhaust located at top of vehicle, and other vehicles with the exhaust located above the vehicle) are expected to range from 84 to 86 dBA at 55 mph at 50 feet from the source (Michael Minor and Associates 2005). For comparison, typical noise levels for passenger vehicles (e.g., normal passenger vehicles, small and regular pickup trucks, small to mid-sized sport utility vehicles, etc.) are expected to range from 72 to 74 dBA at 55 mph at a distance of 50 feet from the source.

Based on information obtained from Research and Innovation Technology Administration Bureau of Transportation Statistics (2010) there were 135.9 million passenger vehicles and 6.8 million single-unit two-axle six-tire or more trucks registered in the United States in 2007. Therefore, without performing a project-specific traffic study, it is anticipated that ore haul truck traffic would make up a rather small percentage of the normal highway traffic. Note the “typical” 300-tpd uranium mine will require 12 to 16 25-ton ore haul truck trips per day.

4.10.4 Impacts Common to All Alternatives

Under Alternatives A through D, mine noises are estimated to be greater than the natural ambient sound levels of the non-tourist areas of the Park (18.3–22.8 dBA) at distances within 2,360 m or 2.3 km (7,740 feet, or 1.5 miles) from a mine site and 2,220 m or 2.2 km (7,280 feet, or 1.4 miles) from ore haul trucks. However, some attenuation would occur as a result of the vegetation and distance’s acting in unison. Figure 4.10-1 illustrates the area of influence as predicted by the above values. The dashed lines represent the maximum distance from the highest dBA reading for the equipment roster to the distance at which that highest decibel reading attenuates to the 20.8 dBA. The 20.8 dBA value is consistent with the natural ambient background for non-tourist areas of the Park.

Based on the report titled *Mining Adjacent to Grand Canyon National Park: Potential Impacts to the Natural Soundscape of the Park* (Ambrose 2010a), the noise from operation of an underground uranium mine, depending on the location, could be audible in some areas of the Park. It is likely the Grand Canyon rim will block some of the noise generated by the mining exploration and development from reaching lower areas of the Grand Canyon. Likewise, vegetative cover above the rim will disrupt noise transmission. In addition, the prevailing wind could affect the attenuation.

Development and operation of proposed underground uranium mines under each alternative as well as currently operating mines (Arizona 1 Mine), and reasonably foreseeable future projects (e.g., VANE claims, EZ-1/EZ-2/Canyon Mine) identified in Appendix B, would involve the use of heavy equipment that would produce noise that could affect ambient soundscapes.

Under Alternatives A through D, exploration and development of a proposed mine sites would cause temporary increases in ambient noise levels in the immediate vicinity of the exploration and development areas. The primary noise sources at a typical underground mine exploration/development sites include operation of heavy-duty diesel equipment (e.g., drill rigs, water trucks, graders, dump trucks, front-end loaders, etc.). The overall noise level generated by the heavy equipment use depends on where the equipment is being used, the number of individual equipment units, and the mitigation measures employed.

The extent of the impact is dependent on the proximity of the mining activity to the Park boundary, the type of equipment used, the topography of the area, direction of the prevailing wind, and hours of equipment operation. Areas of the Park that are closer to mining operations would be impacted more than areas that are farther away, and areas above the rim would likely be impacted more than areas below the rim. The rim of the Grand Canyon will block some of the sounds generated by the mining activities; however, the extent to which sound travels below the rim will vary, based on the meteorological conditions.

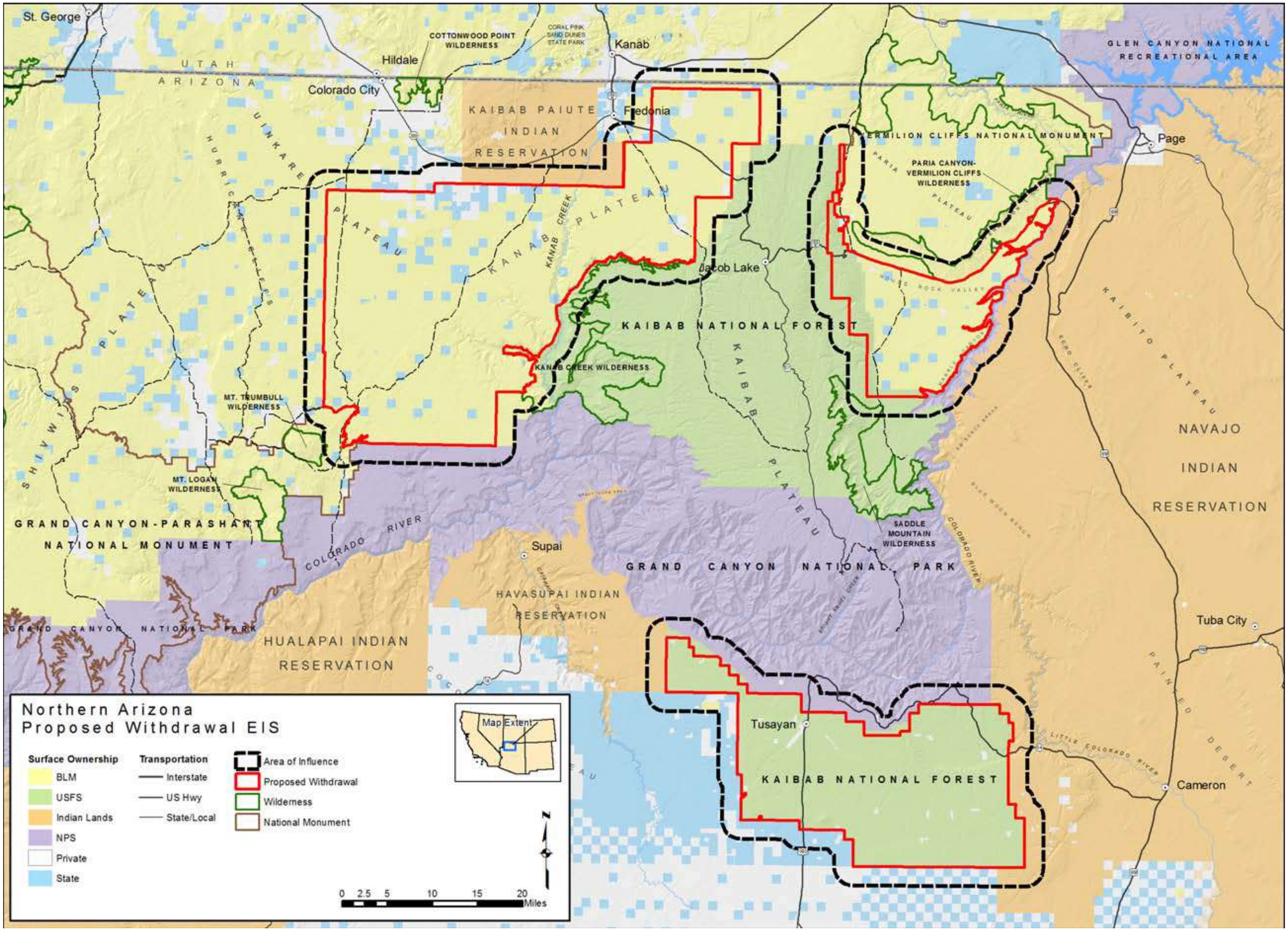

Figure 4.10-1. Soundscapes area of influence.

New technologies such as low-level aerial surveys may be conducted during “prospecting” or exploration activities. Any aerial surveys would be subject to those provisions of the National Parks Overflight Act of 1987 [PL 100-91]. These activities would be short term and transient in nature. The mobility of prospecting operations makes the noise contribution at various receptors temporary and variable. Additional modeling would be required to estimate the noise contribution associated with aerial prospecting.

Compliance with Environmental Regulations and Permitting

Based on good management practices the following measures could be implemented to ensure compliance with environmental regulations and permitting requirements.

- Where possible, the exploration and development activities would be limited to daytime hours (10-hour shifts and a 5-day work week), thus limiting noise on nights and weekends.
- All equipment would be carefully maintained to achieve the lowest practical noise levels (e.g., required to have manufacturer recommended mufflers, tightening loose parts, etc.).
- To the extent feasible, configure the construction site in a manner that keeps noisier equipment and activities as far as possible from NSAs.
- To the extent feasible, mining equipment producing the most noise should be constructed in areas where the topography provides a natural buffer (i.e., locate nosier components in depressions and off of hill crests).

4.10.5 Impacts of Alternative A: No Action (No Withdrawal)

Table 4.10-7 summarizes the activities associated with Alternative A.

Table 4.10-7. Summary of Activity Associated with Alternative A

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	21	2	7
Number of Exploration Projects	504	56	168
Miles of New Road	16.4	2.4	3.6
Number of Haul Trips	221,298	22,240	73,967
Miles of New Power line	16.4	2.4	3.6

Direct Impacts

Under Alternative A, exploration and development of a proposed mine site would cause temporary increases in ambient noise levels in the immediate vicinity of the exploration and development sites. The primary noise sources at a typical underground mine exploration/development site include operation of heavy-duty diesel equipment (e.g., drill rigs, water trucks, graders, dump trucks, front-end loaders, etc.). The overall noise level generated by the heavy equipment use depends on where the equipment is being used, the number of individual equipment units, and the mitigation measures employed.

Under Alternative A, areas with potential mining activity are in relatively remote areas currently devoid of residential or industrial activity. Therefore, the increase in operational noise within the immediate vicinity of the mine operations represents a change to the ambient environment. Furthermore, since portions of the proposed withdrawal area border the Park, it is possible that sounds from mining operations could be audible within these areas. However, quantifying the number of Park visitors whose experience could be disrupted or the impact to wildlife populations would require additional study, specific to individual mines in each parcel.

4.10.6 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, the withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations. After the expiration of the segregation period, the potential withdrawal under Alternative B would restrict the location of new mining claims within the segregation area from exploration, development, and underground uranium mining activities.

Reasonably foreseeable uranium mining exploration activities would occur at 11 exploration sites, leading to the development of 11 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines) and 6.4 miles of new access roads and power lines. Table 4.10-8 summarizes the activities associated with Alternative B.

Table 4.10-8. Summary of Activity Associated with Alternative B

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	10	0	1
Number of Exploration Projects	10	0	1
Miles of New Road	6.4	0	0
Number of Haul Trips	98,978	0	7,247
Miles of New Power line	6.4	0	0

4.10.7 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

The withdrawal under Alternative C would apply to 648,805 acres of federal lands, compared with approximately 1 million acres under Alternative B. The Alternative C withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations. After the expiration of the segregation period, the potential withdrawal under this alternative would restrict the location of new mining claims within the withdrawal area from exploration, development, and underground uranium mining activities similar to that for Alternative B, but would apply to a smaller area.

Under Alternative C, reasonably foreseeable uranium mining exploration activities would occur at 207 exploration sites, leading to the development of 18 mine sites (including Pinenut, Kanab North, Arizona

1, and Canyon Mine) and 12.1 miles of new access roads and power lines. Table 4.10-9 summarizes the activities associated with this alternative.

Table 4.10-9. Summary of Activity Associated with Alternative C

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	13	1	4
Number of Exploration Projects	94	28	85
Miles of New Road	9.1	1.2	1.8
Number of Haul Trips	132,338	11,120	40,607
Miles of New Power Line	9.1	1.2	1.8

4.10.8 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, a withdrawal would apply to approximately 292,088 acres of federal lands and the withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid rights were first established. Mineral exploration and development on mining claims with valid existing rights would continue under the respective BLM or Forest Service surface management regulations.

Under this alternative, reasonably foreseeable uranium mining exploration activities would occur at 431 exploration sites, leading to the development of 26 mine sites (including Pinenut, Kanab North, Arizona I, and Canyon Mines) and 19.1 miles of new access roads and power lines. Table 4.10-10 summarizes the activities associated with Alternative D.

Table 4.10-10. Summary of Activity Associated with Alternative D

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	20	1	5
Number of Exploration Projects	290	28	113
Miles of New Road	15.5	1.2	2.4
Number of Haul Trips	210,178	11,120	51,727
Miles of New Power Line	15.5	1.2	2.4

4.10.9 Cumulative Impacts

Based on the RFD and normal operating scenarios, the noise generating equipment identified in this section would not operate simultaneously. Moreover, the number of activities is limited by the alternatives, and not all mines would be developed concurrently.

It is anticipated that a maximum of two mines would operate simultaneously in the North Parcel and that no more than one mine each would operate within the East and South parcels. The majority (approximately 77%) of the mining development and operations would take place on the North Parcel. However, cumulative impacts to soundscapes are a function of the specific noise sources and their specific location to the NSA. Without this knowledge, noise modeling, which considers conditions such as the height and placement of the source (relative to any obstruction), the spectrum of the source and its duration (steady or transient), the size and density of vegetation, and the atmospheric conditions, cannot be conducted.

As was discussed in Chapter 3, with respect to soundscapes, any future uranium mine would need to demonstrate through site-specific analysis the contribution of that source to the area. This analysis would include a modeling or measurement exercise to determine the cumulative impacts on the region's noise sensitive areas. The majority of the development effects of the reasonably foreseeable future mining projects would be mitigated by the fact that these projects would be constructed over different periods. Both development- and operation-related noise is not expected to have a significant impact on the soundscape within the area, since the mines would likely have varying development schedules and must adhere to federal, state, and local regulations for the protection of ambient noise levels.

It is recognized there would be other noise-generating activities within the proposed withdrawal parcels such as recreational vehicles, OHV use, aerial tours, etc. While these activities could contribute to cumulative impacts, the nature of the noise caused by these sources is completely dependent on the number and location of their operation and is by nature transient. Future projects will be required to undergo NEPA analysis based on individual proposed actions. The NEPA process will require a determination of direct, indirect, and cumulative impacts specific to each mine location. Without specific information regarding the location and duration of the operation of these sources, no substantive estimates of the addition of cumulative noise can be presented in this level of evaluation.

4.11 CULTURAL RESOURCES

4.11.1 Impact Assessment Methodology and Assumptions

For the purposes of this analysis, cultural resources are defined as prehistoric and Historic period archaeological sites and historic buildings or structures. Cultural resources that are primarily valued for their importance to American Indian tribes, such as TCPs and sacred sites, are addressed separately in Section 4.12, American Indian Resources. As American Indian tribes also ascribe importance to places and archaeological sites connected to their ancestors and oral histories, many archaeological sites may also be places of traditional religious or cultural importance.

Effects include both direct and indirect effects. Direct effects are those that occur during the action and in the location of the action; indirect effects are those that occur either removed in time or space from the action. Adverse effects are generally evaluated in regard to the specific criteria that make a property eligible for inclusion in the NRHP (see Section 3.11.1). Adverse impacts on cultural resources result from physical destruction, damage, or alteration of all or part of the property, or from alterations to the site's setting when the character of setting contributes to its eligibility. Such alterations could include visual, audible, or atmospheric elements that are out of character with the setting. A project may also result in no adverse effects; in those cases, an action does have an impact to a resource, but the impact either does not harm the resource or the harm to the resource can be successfully mitigated.

Direct adverse impacts from mining activities could include disturbance resulting from exploration, construction, mine operation, road construction and use, and reclamation. Direct or indirect impacts could result from effects on one or more aspects of integrity (location, design, setting, materials, workmanship, feeling, and association), which would disturb the character of the setting. Indirect impacts could include loss of opportunities for interpretive development or educational uses as a result of loss of integrity or diminished qualities of setting.

The nature and magnitude of the impacts would depend on the specific location and scope of the proposed exploration or development activities. Tables 4.11-1 and 4.11-2 provide definitions of impact magnitude and duration, respectively, as they relate to cultural resources.

Because cultural resources are location specific and the actual locations of the possible mining activities are unknown at this time, this analysis assumes that all future mining-related activities have the potential to affect any of the resources, except where noted. The primary indicator of impacts to cultural resource sites is disturbance. Cultural resources are irreplaceable once disturbed or damaged and cannot be reclaimed, so that any disturbance to a site can be considered a major impact. However, existing mining regulations do address cultural resource disturbance through mitigation (see below). Conversely, it is possible that a given mining project would not adversely affect cultural resources if no resources will be disturbed.

Table 4.11-1. Magnitude and Degrees of Effects on Cultural Resources

Attribute of Effect	Description Relative to Cultural Resources
Magnitude	
No Impact	Would avoid resource.
Minor	Mining-related impacts would occur but resources would retain existing characteristics that make it eligible for the NRHP.
Moderate	Mining-related impacts would occur, and resources would partially retain existing characteristics that make it eligible for the NRHP; however, resource's eligibility would need to be re-evaluated.
Major	Mining-related impacts that would result in loss of the NRHP eligibility of the resource.

Table 4.11-2. Duration Definition of Effects on Cultural Resources

Duration	Definition
Temporary	Up to 1 year (periods of development and reclamation) (auditory and visual only)
Short-term	1 to 5 years (auditory and visual only)
Long-term	Greater than 5 years (all impacts caused by ground disturbance are long-term)

In the following impact analysis, cultural resource sites were classified into four categories based on documented NRHP determinations and evaluations: 1) listed in the NRHP, 2) eligible for listing in the NRHP, 3) not eligible for listing in the NRHP, and 4) unevaluated with respect to status for listing in the NRHP. Sites currently classified as unevaluated are still considered in this analysis because unevaluated sites are treated as eligible by the BLM and Forest Service until they are determined ineligible for the NRHP. The following analysis of potential impacts takes into account the RFD scenarios for the predicted numbers and areal extent of exploration and development activities under each alternative. It is assumed that the majority of development would occur in the North Parcel, with less on the South Parcel and very little in the East Parcel; however, the RFD scenarios cannot predict precisely where the potential mines could be developed.

For each parcel proposed for withdrawal, a Class I cultural resources inventory of existing records and databases was completed in order to identify known cultural resources. The majority of the areas within each parcel have not been subjected to on-the-ground archaeological surveys. Survey coverage varies from less than 10% of the North and East parcels to less than 25% of the South Parcel. Therefore, the exact number of cultural resources on each parcel is unknown. Site density per acre surveyed varies across the three parcels. The North Parcel has a site density of 0.03 site per surveyed acre, the East Parcel has a site density of 0.05 site per surveyed acre, and the South Parcel has a site density of 0.02 site per surveyed acre. These numbers do not take into account differences in environment or terrain that may affect site density.

4.11.2 Compliance with Environmental Regulations and Permitting

The implementation of mitigation measures according to current mining regulations would reduce adverse impacts to cultural resources. The primary mitigation measure would be avoidance. Under all the alternatives, areas proposed for mine development would be subjected to intensive archaeological surveys to identify and evaluate cultural resources that could be affected. Impacts to cultural resources would be considered and addressed through the NEPA and Section 106 processes, with efforts made to identify, avoid, mitigate, or otherwise resolve any adverse effects.

Mitigation of adverse effects on specific sites would be based on the sites' NRHP eligibility criteria. For example, sites eligible under Criterion D, the potential to provide significant information about the past, can often be mitigated through data recovery. Data recovery procedures could include excavations, mapping, collection of artifacts and other archaeological materials, archival research, or oral histories. Final reports would be required to document the results of analysis, with collections and data preserved for long-term research in a museum or other federally approved repository. American Indian tribes would be consulted in developing related research designs, plans, and procedures. The agencies would comply with the provisions of the Native American Graves Protection and Repatriation Act to address any discoveries of materials protected under that law.

Other potential mitigation measures include avoidance of impacts through the design or relocation of activities or facilities; required education of workers to ensure that they understand and comply with cultural resource protection measures; and implementation of discovery plans to address any unexpected finds during exploration, construction, or operation. Mitigation measures near access roads could include implementation of site monitoring plans to detect violations and support enforcement of the Archaeological Resources Protection Act.

Visual intrusions could be mitigated through measures designed to reduce visual impacts by lowering the contrast of mining-related facilities with the surrounding terrain and viewshed. Auditory intrusions could be mitigated through scheduling of mining activities to avoid sensitive times of the year. Reclamation could restore aspects of the setting after mining activities conclude. However, it may not be possible to reduce all such adverse effects in the long term, especially impacts to the character, association, and feeling of the setting.

4.11.3 Incomplete or Unavailable Information

As described above, survey coverage of the proposed withdrawal parcels ranges from less than 3% for the East Parcel, 5% for the North Parcel, and 23% for the South Parcel. As discussed in Section 3.11, the site density as measured by sites per surveyed square mile is 13.7 sites per surveyed square mile for the North Parcel; 32.3 sites per surveyed square mile for the East Parcel; and 14.7 sites per surveyed square mile for the South Parcel. There are more than 2,000 known sites, indicating that the parcels include several thousand cultural resource sites yet unrecorded, many of which are likely to be eligible for the NRHP and could be affected by mining activities; however, sufficient information is available to analyze potential effects on cultural resources types. Although the specific locations of potential mining activities are not defined, the RFD scenarios provide sufficient information to support the alternatives impact analysis.

4.11.4 Alternative A: No Action (No Withdrawal)

Under Alternative A, each parcel would be open for the entry and location of new mining claims. The RFD scenario estimates that 26 new mines would be developed, in addition to the four mines that are currently in operation or in interim management mode. The 30 mines would also involve 728 exploratory projects.

Direct and Indirect Impacts

In the North Parcel, the RFD scenario estimates that 18 new mines would be developed over the next 20 years, in addition to the three existing mines, involving 504 exploration projects. Exploration drilling involves drilling several holes to confirm the presence of a breccia pipe, its boundaries, and presence of mineralization. In some cases, a shaft may be sunk to intercept the ore. Exploration sites are routinely moved to avoid sensitive resources, including cultural resources. Including new roads, the projection is a total of 945 acres disturbed. Depending on the location of the mining activities, cultural resources could be directly impacted by the disturbance of 945 acres. There are 623 known cultural resource sites, as well as sites yet to be discovered, in this parcel (Table 4.11-3). One area of concern is the Kanab Creek watershed, the location of the current uranium mines. The Kanab Creek area is known to contain a high density of significant cultural resources, likely associated with the presence of water sources and springs.

In the East Parcel, the RFD scenario estimates that two new mines would be developed over the next 20 years, involving 56 exploration projects. Including new roads, the projection is a total of 107 acres disturbed, which could directly impact cultural resources. There are 171 known cultural resource sites in this parcel (see Table 4.11-3). Areas of concern, which contain significant known sites, border the Vermilion Cliffs, Colorado River, and the western margin of the parcel at the base of the Kaibab Plateau.

Table 4.11-3. National Register of Historic Places Status of Known Sites by Parcel for Alternative A

	North	East	South	Total
Listed	0	1	11	**12**
Eligible	119	60	268	**447**
Ineligible	97	7	92	**196**
Unevaluated	407	103	1,370	**1,880**
Total	**623**	**171**	**1741**	**2,535**

In the South Parcel, the RFD scenario estimates that six new mines would be developed over the next 20 years, involving 168 exploration projects. Including new roads, the projection is a total of 312 acres disturbed, which could directly impact cultural resources. This parcel includes 1,741 known cultural resource sites (see Table 4.11-3). Information from past surveys indicates a high density of cultural resources throughout the parcel.

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting by construction of new roads. There would be 16.4 miles of new roads in the North Parcel, 2.4 miles in the East Parcel, and 3.6 miles in the South Parcel.

Cumulative Impacts

Cumulative impacts are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other activities" [40 CFR 1508.7]. For cultural resources, the loss of resources over time and space may result in an alteration to the historic (including prehistoric) character and integrity of a place. Past actions such as livestock grazing allotments on Forest Service land have contributed in a minor way to disturbance and erosion of cultural resources; however, this disturbance is not considered significant overall. Site condition data for cultural resources on BLM land were not available; however, similar amounts of disturbance can reasonably be assumed for the portions of the proposed withdrawal area on BLM lands. Examples of past, present, and future projects include, but are not limited to, the Grand Canyon National Park Airport Fuels Reduction Project, the Designation of Energy Corridors on Federal Land in the 11 Western States EIS, the Orphan Mine, the Arizona 1 Mine, the EZ1 and EZ2 Mines, the What Mine, the VANE Minerals Uranium Exploratory Drilling Project EIS, the Four Forest Restoration Initiative, the Kaibab National Forest Travel Management EAs, and the Plateau Facility Fire Protection Project EA. For all of these projects, the amount and type of disturbance to sites would be the primary impact indicator; however, existing regulations stipulate that all past, present, and future projects, including mining applications, construction of utility lines, fire management, etc., on federal lands are subject first to cultural resources inventory. If sites are found during this inventory, disturbance to those sites must be mitigated. Since avoidance is the primary mitigation measure for any project, it can be assumed that the total number of cultural resources that would need to be mitigated further through data recovery or other means for these projects is minimal and would not significantly change the historic or prehistoric character of the parcels; therefore, no cumulative impacts to cultural resources are anticipated under Alternative A.

4.11.5 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Because all three parcels, approximately 1,000,000 acres, would be withdrawn and no new exploration or claims would be allowed for 20 years, new mining activities would be focused on the exploration and development of valid existing claims. The RFD scenario estimates that 11 mines would be developed during the 20-year period.

Direct and Indirect Impacts

In the North Parcel, the RFD scenario estimates that 10 mines would be developed over the next 20 years, involving 10 associated exploration projects. Including new roads, the projection is a total of 163 acres disturbed, which could directly impact cultural resources. There are 623 cultural resource sites within the North Parcel. Mining-related impacts to cultural resources would be limited to the mine development areas. Throughout the rest of the parcel, cultural resources would not be affected by new mining activities.

In the East Parcel, no new mines would be developed, and there would be no exploration projects. The entire area would be excluded from impacts associated with mining.

In the South Parcel, the RFD scenario estimates that one existing mine would be further developed, with one exploration project and no new roads. Disturbance from the exploration project would be approximately 1 acre. Any cultural resource sites at or near the mine development could be impacted by mining activities. In the rest of the parcel, cultural resources would not be affected by new mining activities.

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting through construction of 6.4 miles of new roads in the North Parcel.

Cumulative Impacts

For the same reasons as identified for Alternative A, no cumulative impacts to cultural resources are anticipated under Alternative B.

4.11.6 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Under Alternative C, approximately two-thirds of the area proposed for withdrawal under Alternative B, or approximately 650,000 acres, would be withdrawn from mineral entry for 20 years. The RFD scenario anticipates the development of 18 new mines.

Direct and Indirect Impacts

In the North Parcel, 351,967 acres would be withdrawn, focused on the Kanab Creek watershed, ACECs, and other areas containing sensitive cultural resource values. The RFD scenario estimates that 13 mines would be developed, involving 94 exploration projects. Including new roads and exploratory projects, the projection is a total of 320 acres disturbed, which could directly impact cultural resources. There are 82 known cultural resource sites in areas excluded from withdrawal. For the 541 known sites in the area proposed for withdrawal, impacts from new mining activities would be limited to those associated with the development of valid existing claims (Tables 4.11-4 and 4.11-5).

Table 4.11-4. National Register of Historic Places Status of Sites within Alternative C Withdrawal Boundaries, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	0	0	9	**9**
Eligible	113	13	223	**349**
Ineligible	89	7	66	**162**
Unevaluated	339	71	968	**1,378**
Total	**541**	**91**	**1,266**	**1,898**

Table 4.11-5. National Register of Historic Places Status of Sites in Areas Excluded from Withdrawal under Alternative C, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	0	1	2	**3**
Eligible	6	47	45	**98**
Ineligible	8	0	26	**34**
Unevaluated	68	32	402	**502**
Total	**82**	**80**	**475**	**637**

In the East Parcel, 90,234 acres would be withdrawn, focused on areas containing sensitive cultural resource values. The RFD scenario estimates that one new mine would be developed, involving 28 exploration projects. Including new roads and exploratory projects, the projection is a total of 54 acres disturbed, which could directly impact cultural resources. There are 80 known cultural resource sites in areas excluded from withdrawal. The 91 known sites in the area proposed for withdrawal would avoid direct impacts associated with mining (see Tables 4.11-4 and 4.11-5).

In the South Parcel, 206,603 acres would be withdrawn, focused on Red Butte, zones adjacent to Grand Canyon National Park, and other areas containing sensitive cultural resource values. The RFD scenario estimates that four mines would be developed, involving 85 exploration projects. Including new roads and exploratory projects, the projection is a total of 158 acres disturbed, which could directly impact cultural resources. There are 475 known cultural resource sites in areas excluded from withdrawal. For the 1,266 known sites in the area proposed for withdrawal, impacts from new mining activities would be limited to those associated with the development of valid existing claims (see Tables 4.11-4 and 4.11-5).

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting through construction of 9.1 miles of new roads in the North Parcel, 1.2 miles in the East Parcel, and 1.8 miles in the South Parcel.

Cumulative Impacts

For the same reasons as identified for Alternative A, no cumulative impacts to cultural resources are anticipated under Alternative C.

4.11.7 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately one-third of the area proposed for withdrawal under Alternative B, approximately 300,000 acres, would be withdrawn from mineral entry for 20 years. The RFD scenario anticipates the development of 26 new mines.

Direct and Indirect Impacts

In the North Parcel, 102,581 acres would be withdrawn, focused on areas containing multiple sensitive resource values. The RFD scenario estimates that 17 new mines, in addition to the three existing mines, would be developed, involving 290 exploration projects. Including new roads and exploratory projects, the projection is a total of 688 acres disturbed, which could directly impact cultural resources. There are 408 known cultural resource sites in areas excluded from withdrawal. For the 215 known sites in the area approved for withdrawal, impacts from new mining activities would be limited to those associated with the development of valid existing claims (Tables 4.11-6 and 4.11-7).

In the East Parcel, 56,233 acres would be withdrawn, focused on areas containing multiple sensitive resource values. The RFD scenario estimates that one new mine would be developed, involving 28 exploration projects. Including new roads and exploratory projects, the projection is a total of 54 acres disturbed, which could directly impact cultural resources. There are 96 known cultural resource sites in areas excluded from withdrawal. The 75 known sites in the area proposed for withdrawal would avoid direct impacts associated with mining (see Tables 4.11-6 and 4.11-7).

Table 4.11-6. National Register of Historic Places Status of Sites within Alternative D Withdrawal Boundaries, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	0	0	8	**8**
Eligible	42	9	170	**221**
Ineligible	37	5	46	**88**
Unevaluated	136	61	591	**788**
Total	**215**	**75**	**815**	**1,105**

Table 4.11-7. National Register of Historic Places Status of Sites in Areas Excluded from Withdrawal under Alternative D, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	0	1	3	**4**
Eligible	77	51	98	**226**
Ineligible	60	2	46	**108**
Unevaluated	271	42	779	**1,092**
Total	**408**	**96**	**926**	**1,430**

In the South Parcel, 133,274 acres would be withdrawn, focused on areas containing multiple sensitive resource values. The RFD scenario estimates that four new mines would be developed, involving 113 exploration projects. Including new roads and exploratory projects, the projection is a total of 209 acres disturbed, which could directly impact cultural resources. There are 939 known cultural resource sites in areas excluded from withdrawal. For the 815 known sites in the area proposed for withdrawal, impacts from new mining activities would be limited to those associated with the development of valid existing claims (see Tables 4.11-6 and 4.11-7).

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting through construction of 15.5 miles of new roads in the North Parcel, 1.2 miles in the East Parcel, and 2.4 miles in the South Parcel.

Cumulative Impacts

For the same reasons as identified for Alternative A, no cumulative impacts to cultural resources are anticipated under Alternative D.

4.12 AMERICAN INDIAN RESOURCES

4.12.1 Impact Assessment Methodology and Assumptions

American Indian resources consist of many types of places, including tribal homelands, places of traditional importance, traditional use areas, trails, springs and waterways, and sacred sites. Each of these places is associated with values that contribute to sustaining the culture; these values are associated with cultural heritage, respect for ancestors, spirituality, education, economics, and social relationships. Some of these places and areas may be recognized as TCPs by the federal government; however, many are not. Although these places and areas have not been through the formal nomination process as TCPs, they are no less important to American Indians and their cultures and must be considered when evaluating the impacts of an undertaking. TCPs may also be associated with non–American Indian groups; however, there are no non–American Indian TCPs in the proposed withdrawal area.

For American Indian resources, adverse impacts are varied and sometimes difficult to measure. In many cases, American Indian perception of adverse impacts is as important as any physical and measurable impact. Possible adverse impacts from activities that could occur under the proposed withdrawal, the action alternatives, or the No Action Alternative could include the following:

- direct damage, disturbance, or destruction of places, resulting from exploration, construction, operation, transportation, and reclamation activities;
- any “wounding” of the earth through drilling or mining;

- disturbance of graves, human remains, or other materials protected under the Native American Graves Protection and Repatriation Act;
- visual, audible, or atmospheric elements that adversely affect the integrity and values of resources;
- impediments to traditional practices or land uses;
- restricted access to traditional use areas or sacred sites;
- disruption of a place's setting or its association with other important places, resulting from visual or auditory impacts;
- loss of springs or declines in quantity or quality of important water sources;
- social impacts such as distress or anxiety caused by effects on cultural values and sense of place, or fears of loss, illness, or resource contamination.

Some of these impacts can be mitigated, while others cannot. Mitigation may be difficult or impossible in many cases, as alterations or damage to the values of significant, connected places may be irreversible and irreparable, regardless of reclamation; however, some potential mitigation measures include the following:

- avoidance or reduction of impacts through relocation or redesign of activities or facilities;
- measures implemented to reduce visual impacts, air quality impacts, and noise.
- access routes provided or kept open to traditional use areas and sacred sites.
- reclamation to restore aspects of setting.

Areas of potential traditional religious or cultural importance within the proposed withdrawal area were identified through a search of published literature and consultation with American Indian tribes (Hedquist and Ferguson 2010). In order to determine potential impacts from activities that could occur under the proposed withdrawal, the action alternatives, or the No Action Alternative, locations of traditional cultural importance, including sacred places, were compared against possible mine site locations. Although acreage of possible disturbance was taken into consideration in the analysis**,** any disturbances or damage to places of cultural importance to tribes are likely to be perceived as significant. Tables 4.12-1 and 4.12-2 provide definitions of impact magnitude and duration, respectively, as they relate to American Indian resources.

Table 4.12-1. Magnitude and Degrees of Effects on American Indian Resources

Attribute of Effect	Description Relative to Cultural Resources
Magnitude	
No Impact	Would avoid resource.
Minor	Mining-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians.
Moderate	Mining-related impacts would occur, and resources would partially retain existing characteristics vital to their cultural functions and uses by American Indians. Some functionality of resource may be lost.
Major	Mining-related impacts that would result in loss of resource and/or functional use of resource.

Table 4.12-2. Duration Definition of Effects on American Indian Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation) (auditory and visual only)
Short-term	1 to 5 years (auditory and visual only)
Long-term	Greater than 5 years (all impacts caused by ground disturbance are long-term)

In order to determine potential impacts activities that could occur under the proposed withdrawal, the action alternatives, or the No Action Alternative for each alternative, the analysis evaluated the presence of documented ethnographic resources that could be affected by mineral exploration and development. Any disturbance or damage to these places, regardless of size, may be perceived by American Indians as significant because it may disrupt the function of these particular places.

The information provided in the ethnographic report should not be considered comprehensive. Many places important to tribes are not identified in the report because many tribes feel that they should not share sacred and tribal knowledge with outsiders; the resources mentioned here likely represent a fraction of the total number of American Indian resources within the proposed withdrawal area. Any mining activity has the potential to affect yet-unidentified resources within the proposed withdrawal area.

The RFD scenarios estimate the likely number of mines for each parcel; however, they cannot precisely predict the locations of the mines. For the purposes of this analysis, it will be assumed that the majority of development would occur in the North Parcel, substantially less in the South Parcel, and little if any in the East Parcel; however, given the limited data, it is extremely difficult to predict within an individual parcel where any mines might eventually be developed. Because the actual locations of the possible mines are unknown, this analysis assumes that each mine has the potential to affect any of the resources, except where noted. The cumulative impact analysis area was confined to the boundaries of the proposed withdrawal area.

It is important to note that many American Indians view exploratory drilling and mining as wounding the earth. Past mining activities that are visible on the surface are seen as wounds that cannot scab over or heal (Nuvamsa 2008). Any drilling into the earth, regardless of size, is considered a wound to the earth. In commenting on other projects in the withdrawal area, the Hopi have repeatedly stated that the earth is sacred and should not be dug up for commercial reasons (Forest Service 1986a). Other tribes believe that repeated wounding of the earth can kill their deities and by extension a sacred site. In their lawsuit against the U.S. government over the Canyon Uranium Mine, the Havasupai stated that “the Canyon Mine site is sacred and any mining will interfere with their religious practices at and near the mine, and will kill their deities, and destroy their religion” (Havasupai Tribe *v*. United States 1992).

4.12.2 Compliance with Environmental Regulations and Permitting

Since damage to traditional cultural and sacred places is irreversible, the preferred mitigation measure is avoidance. The BLM and Forest Service are required to consult with interested tribes on a government-to-government basis and attempt to address their concerns (BLM 2010h). The consultation process consists of informative letters, phone calls, emails, and formal meetings with tribal elected officials. Meetings are held either near or on the various reservations and allow for tribal members to ask questions and offer their opinions about proposed drilling and mining projects. Draft versions of relevant documents such as archaeological and ethnographic studies and draft EAs and EISs are provided for review by tribal members. Concerns expressed by tribal members are then incorporated into the final versions of these documents, as long as those concerns are not deemed confidential by tribal members. Confidential issues are addressed without releasing information to the public, to the extent that information is protected by laws including the National Historic Preservation Act, Archaeological Resources Protection Act, and Freedom of Information Act (BLM 2010h). If a conflict arises, mine operators, if possible, could then attempt to relocate drill or mining locations that are particularly sensitive to the interested tribes as mitigation of potential adverse impacts; however, since any drilling or excavation into the earth is considered wounding the earth, it may not be possible to mitigate all impacts by moving locations. If relocation is not possible, other mitigation measures would be agreed upon by the BLM, the interested tribes, and the mine operators.

4.12.3 Incomplete or Unavailable Information

Further information has been added to the Final EIS based on additional tribal consultations and completion of the NPS ethnographic report (Hedquist and Ferguson 2010). Although additional information could come to light through further ethnographic research, the available information supports the analysis of impacts on American Indian resources.

4.12.4 Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, the proposed withdrawal area would be open for the location and entry of new mining claims once the segregation order is lifted or expires.

Direct and Indirect Impacts

In the North Parcel, the RFD scenario estimates that over the next 20 years, 18 new mines would be developed, in addition to the three existing mines, which would result in 945 acres of total new disturbance. In addition, 504 exploratory projects would occur. This new disturbance includes new roads and power lines, in addition to the actual exploration and mine disturbance; however, the exact location of this disturbance is unknown.

The 945 acres of new disturbance would disturb a portion of the traditional territory of the Southern Paiute, which encompasses the North and East parcels. Although the amount of disturbance of the landscape would be on a small scale, the area is seen by the Southern Paiute as an interconnected series of places, and it is possible that the disturbance could be significant if an especially important place was damaged.

The three current mines on the North Parcel—Pinenut, Kanab North, and Arizona 1—are all located within the Kanab Creek Ecoscape of the Southern Paiute, as are two of the three previously reclaimed mines on the parcel; therefore, it is reasonable to assume that the Kanab Creek Ecoscape would be disturbed in a higher proportion to the rest of the parcel under Alternative A. In addition, the exploratory drilling and the mines predicted for the North Parcel could disturb, or be perceived by American Indian groups to disturb, a ceremonial site and the portion of the Kanab Creek and the Kanab Creek trail not located within the Kanab Creek Wilderness by disrupting the cultural function of these places. Other resources whose traditional use may be disrupted under Alternative A in the North Parcel include Moonshine Spring, Yellowstone Spring, and Antelope Spring, the Kaibab band and Uinkaret band territories, trails and access route to sacred places south of the parcel, and three resource procurement areas on the parcel.

In the East Parcel, the RFD scenario under Alternative A estimates that two new mines would be developed, with a total of 107 acres of disturbance, as well as 56 exploratory projects. The Aesak traditional use area of the Southern Paiute encompasses the entire House Rock Valley, which includes the East Parcel; therefore, the 107 estimated acres of disturbance would disturb the Aesak area. It is possible that some areas of the landscape may be more sensitive to damage than others; this would need to be established through tribal consultation.

The two springs at Kane Ranch, the trails crossing the valley, and the four resource procurement areas could be disturbed by future mining activity; any disturbance to these resources would be considered significant in that it would disrupt the function and cultural association of the resources.

In the South Parcel, the RFD scenario under Alternative A estimates that over the next 20 years, 168 exploratory projects would occur, as well as the development of seven mines, which would result in 312 acres of total new disturbance. Currently, there are slightly more mining claims in the southern portion of the parcel near Red Butte, which indicates that Red Butte has a greater risk of being disturbed by new mines. Red Butte which has been determined a TCP eligible for the NRHP is an important ceremonial site for several tribes and is particularly sensitive to ground, visual, and noise disturbances. Any activities associated with mining have the potential to disrupt ceremonial activities at and near Red Butte, as well along the travel corridor from Red Butte to the Grand Canyon and along several trails leading to and from Red Butte. Although mining activities may only take place for a few years per mine some tribes may assert that any disruption in ceremonial activities would be considered detrimental to their culture.

The Navajo traditional territory, which encompasses the entire Coconino Plateau, a Navajo traditional use area, a Hopi traditional use area, a Hualapai traditional use area, and the Havasupai traditional range are also all at high risk for disturbance since they encompass large amounts or even all of the South Parcel. In addition, several American Indian trails, a Navajo ceremonial site, two Havasupai seasonal camps, a Southern Paiute deer hunting location, and traditional use plants and animals are also at risk of disturbance.

Under Alternative A, indirect impacts to American Indian traditional sacred and cultural places would consist of increased traffic, which could increase the likelihood of intentional as well as unintentional damage to resources. Increased traffic would also contribute to higher noise levels.

Other indirect impacts to traditional cultural or sacred places include possible visual or skyline impairment during operation. It is estimated that approximately 20 acres would be disturbed by each mine site which could be within the viewshed of a traditional cultural or sacred place. Any new power lines may also disrupt the skylines seen from a traditional cultural or sacred place. In addition, the increased noise from operations and haul trucks may disrupt ceremonial activity near sacred places within the Kanab Ecoscape and at the three springs. Both visual and noise impacts may also be considered direct impacts, depending on how far away the disturbance is from a particular traditional cultural or sacred place.

Cumulative Impacts

The implementation of NEPA requires the consideration of cumulative impacts, which are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other activities” [40 CFR 1508.7]. For American Indian resources, the disturbance of traditional cultural and sacred places over time and space can result in the loss of function and sacredness of these places. Past, present, and future projects that result in ground disturbance or visual impacts, such as construction within energy corridors and any other type of mining, could result in disturbance to American Indian traditional cultural and sacred places over time and space. This disturbance, combined with that predicted for Alternative A, could reduce the functionality of traditional cultural and sacred places. Examples of past, present, and future projects include the Grand Canyon National Park Airport Fuels Reduction Project, the Designation of Energy Corridors on Federal Land in the 11 Western States EIS, the Orphan Mine, the Arizona 1 Mine, the EZ1 and EZ2 Mines, the What Mine, the VANE Minerals Uranium Exploratory Drilling Project EIS, the Four Forest Restoration Initiative, the Kaibab National Forest Travel Management EAs, and the Plateau Facility Fire Protection Project EA. The addition of exploratory drilling or mining to other ground-disturbing projects can harm or even “kill” sacred sites in or near the place of disturbance. In addition, Indian Trust Resources outside the proposed withdrawal area could be damaged from the combination of mining activities. One place of concern is Havasupai Springs, which may suffer from contamination from the mining activity as well as from effects of other activities (see Section 4.4, Water Resources).

4.12.5 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 1,006,545 acres of BLM and Forest Service lands would be withdrawn from mineral location and entry for 20 years. In addition, new exploration and development would only occur on mining claims determined to be valid.

Direct and Indirect Impacts

Under Alternative B, in addition to the three existing mines in the North Parcel, seven additional known mineralized breccia pipes would likely be developed, for a total of 10 mines and 10 exploratory projects. These 10 mines would result in 163 acres of disturbance from exploration, new power lines, and new roads. As these known mineralized breccia pipes are located along the Kanab Creek Ecoscape, along the Kanab Creek Ecoscape the impacts from projected mine development would be similar to Alternative A. The total acreage of possible disturbance would be less, meaning that a smaller percentage of the Kanab Creek Ecoscape and possibly portions of the Kanab Creek trail not within the Kanab Creek Wilderness would be affected. With the reduced number of mines and exploratory projects, there is less potential for disturbance to the Kaibab band and Uinkaret band territories. None of the springs would be directly disturbed by the mining activity since they are not located near the breccia pipes; however, mining activities areas away from springs could affect the springs through groundwater contamination (see Section 4.4, Water Resources). In addition, there would be a great reduction in the number of exploratory projects from 504 to 10 decreasing, the potential for “wounding” of the earth through drilling.

Under this alternative, no mines would be developed in the East Parcel; therefore, there would be no impacts to any traditional cultural or sacred places.

Under this alternative, only the Canyon Mine would operate in the South Parcel, and only 1 additional acre would be disturbed as a result of exploration. In addition, one exploratory project would occur. This additional acre and single exploratory project are unlikely to significantly disturb a traditional cultural or sacred place; therefore, there would likely be very little to impact American Indian resources in the South Parcel of this alternative. However, both the single acre and the exploratory project may be considered wounding of the earth, as discussed above.

The indirect impacts for Alternative B for the North Parcel would be similar to those under Alternative A, but to a lesser degree, since fewer mines would potentially be developed near American Indian resources. Since there are no mines anticipated for the East Parcel, there would be no indirect impacts for the East Parcel; since only an additional 1 acre for exploration for the existing Canyon Mine is anticipated for future development, any indirect impacts for the South Parcel would be unlikely.

Cumulative Impacts

Although fewer mines would be developed under Alternative B than under Alternative A, the potential for disturbance of places of cultural importance to American Indians within the North Parcel remains a possibility, particularly in areas associated with the development of valid existing claims in the Kanab Creek watershed. Depending on the location of the mining activities, the cumulative impacts under Alternative B could be similar to those under Alternative A for the North Parcel. Since no mines would be developed in the East Parcel, there would be no cumulative impacts of mining for the East Parcel, so the overall cumulative effects from the proposed withdrawal under Alternative B would be less than under Alternative A. The cumulative impacts for the South Parcel would be less than Alternative A; however, because any disturbance to American Indian resources or the earth may be seen as significant to American Indians, the cumulative impacts from mine activities and other projects that would still occur under the proposed withdrawal in Alternative B may be enough to threaten important places and sacred sites.

4.12.6 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Under Alternative C, approximately 648,805 acres of federal lands in the three parcels would be withdrawn from mineral location and entry for 20 years. In addition, new exploration and development would only occur on mining claims determined to be valid.

Direct and Indirect Impacts

In the North Parcel, 351,967 acres would be withdrawn, which would include areas with sensitive resources values. Antelope Spring, portions of the Kaibab and Uinkaret band territories, and part of a resource procurement area are outside the proposed withdrawal boundaries for this alternative. The RFD scenario estimates that in addition to the three existing mines, seven new mines would be developed within the proposed withdrawal area and three in the area excluded from withdrawal, resulting in a total of 320 acres of disturbance. Ten exploratory projects within the proposed withdrawal area and three in the area excluded from withdrawal would also occur. Much of the Kanab Creek Ecoscape would be included within the proposed withdrawal boundaries of Alternative C. The direct impacts of Alternative C for traditional cultural or sacred places would be the same as for Alternative B, except that the likelihood of disturbance to Antelope Spring, the Kaibab band and Uinkaret band territories, and the resource procurement area by one or more of the three mines outside the boundary would be greater.

In the East Parcel, 90,234 acres would be withdrawn; one exploratory project and one new mine with 54 acres of disturbance would be developed in the area excluded from withdrawal.

The withdrawal area for Alternative C would not include the southern portion of the Aesak use area, the two springs at Kane Ranch, and a Southern Paiute hunting area, so the new mine could disturb any of these resources.

In the South Parcel, 206,603 acres would be withdrawn, which would include several sensitive areas. One subsistence locale, portions of the trail network, portions of the Hopi and Navajo traditional use areas, a portion of the Havasupai traditional range, and the Navajo traditional territory would not be included within the withdrawal boundaries under Alternative C. Additionally, traditional use plants and animals in the area excluded from withdrawal would be at risk. One exploratory project is estimated for the proposed withdrawal area and three within the area excluded from withdrawal in the South Parcel. One existing mine and three new mines are estimated for the area excluded from withdrawal over the next 20 years. The direct impacts of Alternative C for traditional cultural or sacred places would be the same as for Alternative B, except that the likelihood of disturbance to the Hopi Trails and the southern portion of the Navajo traditional territory would be greater.

For all three parcels, since fewer mines would be developed than under Alternative A, indirect impacts under Alternative C would be similar but lesser in intensity than under Alternative A. However, they would be greater than under Alternative B since more mines would be developed.

Cumulative Impacts

Although fewer mines would be developed under Alternative C than under Alternative A, like Alternative B, the potential for disturbance of places of cultural importance to American Indians within the North

Parcel is very high. Depending on the location of the mining activities, the cumulative impacts under Alternative C could be similar to those under Alternatives A and B for the North Parcel. Since one mine would be developed in the East Parcel, there would be less cumulative impacts of mining for the East Parcel than under Alternative A, but more than Alternative B. The cumulative impacts for the South Parcel would be less than Alternative A; however, since several resources are outside the proposed withdrawal boundaries the cumulative impacts would be greater than for Alternative B.

4.12.7 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, 292,088 acres of federal lands would be withdrawn from mineral location and entry for 20 years. In addition, new exploration and development would only occur on mining claims determined to be valid.

Direct and Indirect Impacts

In the North Parcel, 102,581 acres would be withdrawn, which would allow 10 exploratory projects within the withdrawal boundaries and 10 exploratory projects in the area excluded from withdrawal. Seventeen new mines would be developed in the area excluded from withdrawal along with the three currently existing mines within the Alternative D boundaries. Yellowstone Spring, Antelope Spring, Moonshine Spring, the trail from Moonshine Spring, two resource procurement areas, portions of the Kaibab band and Uinkaret band territories, and portions of the Kanab Creek Ecoscape and Kanab Creek trail would all be outside the proposed withdrawal borders. The impacts of Alternative D would be greater than that of Alternatives B and C since the potential for disturbance to traditional cultural and sacred places outside the Alternative D boundary would increase. As important water sources and place of increased cultural use, Moonshine Spring, Yellowstone Spring, and Antelope Spring are most at risk.

In the East Parcel, 56,233 acres would be withdrawn; one exploratory project and one new mine are estimated to be developed in the area excluded from withdrawal. Only areas along the eastern and western boundaries of the Alternative B proposed withdrawal would be withdrawn under Alternative D, leaving the central portion of the Aesak use area, the springs at Kane Ranch, and three resource procurement areas all outside the proposed withdrawal boundaries. The potential for disturbance to traditional cultural places for the East Parcel is similar to that of Alternative A.

In the South Parcel, 133,274 acres in the northern portion of the parcel would be withdrawn. Over the 20-year time span, five mines with 209 acres of disturbance are estimated for development in the area excluded from withdrawal. In addition, one exploratory project would occur within the Alternative D boundaries and four would occur in the area excluded from withdrawal. Under Alternative D, Red Butte, one subsistence locale, portions of the trail network, portions of the Hopi and Navajo traditional use areas, and a portion of the Havasupai traditional range would be all be within the area excluded from withdrawal. Additionally, traditional use plants and animals in the area excluded from withdrawal would be at risk. The impacts of Alternative D would be similar to those under Alternative A. Red Butte and the associated travel corridor to the Grand Canyon, identified by many tribes as important cultural areas, would be outside the proposed withdrawal boundaries. Since this area of the South Parcel has been a focus of prior exploration activities, there would be a high potential for disturbance of these resources.

For all three parcels, indirect impacts under Alternative D would be similar but less than under Alternative A, and greater than those anticipated under Alternatives B and C. Fewer mines would be developed under Alternative D than under Alternative A, but it would be more than under Alternative B or C.

Cumulative Impacts

Most resources of importance to American Indians (either whole or in part), including the TCP Red Butte, are outside the proposed withdrawal boundaries for Alternative D. Fewer mines would be developed in all three parcels under Alternative D than under Alternative A; however, because many resources are outside the proposed withdrawal boundaries the potential for disturbance of places of cultural importance to American Indians is almost identical to that of Alternative A.

4.13 WILDERNESS

4.13.1 Introduction

The wilderness impact analysis is an assessment of potential impacts on three designated wilderness areas and one proposed wilderness area that could result from withdrawal from location and entry under the Mining Law (except valid existing rights). As stated in Section 3.13.1, there is one designated wilderness area adjacent to the North Parcel: Kanab Creek. There are two designated wilderness areas adjacent to the East Parcel: Paria Canyon–Vermilion Cliffs and Saddle Mountain. There are no designated wilderness areas adjacent to the South Parcel.

A wilderness proposal was prepared for Grand Canyon National Park in 1980 and sent to the Secretary of the Interior; it was updated in 1993 and awaits further action. The wilderness proposal proposed wilderness designation for 1,109,257 acres and identified an additional 29,820 acres of potential wilderness within Grand Canyon National Park.

4.13.2 Impact Assessment Methodology and Assumptions

As discussed in Chapter 3, the Wilderness Act of 1964 [16 USC 1131–1136] dictates that wilderness areas are managed to protect and preserve their "wilderness character." Analysis of impacts to designated and proposed wilderness areas involves determining whether the potential impacts of the proposed mineral withdrawal would change any of the four tangible qualities of wilderness that make up the description of wilderness character relevant and practical to wilderness stewardship:

- **Untrammeled**: The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man" and "generally appears to have been affected primarily by the forces of nature."
- **Natural**: The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." Wilderness ecological systems are substantially free from the effects of modern civilization.
- **Undeveloped**: The Wilderness Act states that wilderness is an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable."
- **Solitude or a primitive and unconfined type of recreation**: The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation."

To analyze potential impacts to wilderness resources, RFD scenarios of uranium mining activities provide the basis for determining what level of development scenarios would occur under each withdrawal action alternative as compared to the existing conditions (see Appendix B). That is, the true impact of a particular action alternative to wilderness resources is the difference between the impacts under Alternative A and that particular alternative.

Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Tables 4.13-1 and 4.13-2 provide thresholds and descriptions used during analysis for wilderness impacts.

Table 4.13-1. Magnitude and Degrees of Effects on Wilderness Resources

Attribute of Effect	Description Relative to Wilderness
No Impact	Impacts would have no discernible effect on wilderness character. Natural conditions would prevail. There would be no permanent visual improvements or human occupation. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation.
Minor	Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no permanent visual improvements or human occupation. While there might be short-term impacts within the wilderness, over the long term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.
Moderate	Impacts would be readily apparent within limited areas of the wilderness. It would be apparent that man has altered natural conditions within such areas. There would be no permanent visual improvements or human occupation. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted in limited areas and during limited times of the year.
Major	Impacts would substantially alter the wilderness resource throughout the wilderness area. Natural conditions would have been substantially altered by man. Improvements made by man, while not permanent, would be long term and become part of the landscape. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted throughout the wilderness.

Table 4.13-2. Duration Definition of Effects on Wilderness Resources

Duration	
Temporary	Up to 1 year
Short-term	1 to 5 years
Long-term	Greater than 5 years

4.13.3 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

A no-withdrawal scenario is anticipated to involve approximately 728 uranium exploration projects, 30 uranium mines, 317,505 ore haul trips, and 22.4 miles of new roads and power lines, and therefore result in approximately 1,321 acres of disturbed landscape over 20 years, but would not result in any direct impacts to designated and proposed wilderness areas.

Under Alternative A, opportunities for solitude and the ability for users to avoid the sights, sounds, and evidence of other people while visiting designated and proposed wilderness areas would be indirectly disrupted during the life of the mine activity since a withdrawal would not occur. Mining-related construction and operation adjacent to the designated and proposed wilderness could also include an increase in dust and noise levels within these areas during the life of the mine. This disturbance could last approximately 5 years per mine. Further NEPA analysis would be required if the operator modifies its operating plan.

Indirect impacts to the untrammeled character of designated or proposed wilderness could occur if management activities manipulate the components or processes of ecological systems inside the wilderness. This could occur through indirect impacts to vegetation, wildlife, and water resources within the wilderness. Indirect impacts to water resources, vegetation, and fish and wildlife are described in further detail in Sections 4.4, 4.6, and 4.7.

The soundscape analysis discussed in Section 4.10 indicates that operation associated with mining activity would cause increases in ambient noise levels in the immediate vicinity of the mine sites and haul roads; this has the potential to impact natural and undeveloped characteristics of the wilderness area since there would be no withdrawal from the Mining Law under Alternative A. In addition, mining activities within the viewshed of a designated or proposed wilderness area would have an impact on the natural and undeveloped characteristics of the wilderness area. The presence of mineral exploration and development components adjacent or within close proximity to designated or proposed wilderness that could impact the undeveloped and natural characteristics include exploration drilling rigs, mine facilities (building structures, towers, and equipment), roads, power lines, ore-haul traffic, and dust. These components would be inconsistent with the requirement to retain the primeval character of the wilderness.

The recreation analysis discussed in Section 4.15 indicates that operation associated with mining activity under a no-withdrawal scenario would potentially alter the existing recreation setting and opportunity as a result of the presence of new roads in previously non-roaded areas (note that no new roads will be located within the designated or proposed wilderness areas), heavy-haul trucks, and mining facilities. This has the potential to impact solitude or primitive and unconfined recreation within a designated or proposed wilderness located adjacent to or within close proximity of mining activity.

Potential impacts to designated and proposed wilderness depend on placement and density of specific exploration and mining operations and thus become project specific. Mining activities that occur closer to designated or proposed wilderness would have a greater potential impact than those occurring farther away. Portions of the proposed withdrawal area are adjacent to wilderness boundaries; therefore, it is possible that mine exploration, development, and reclamation/closure activities could indirectly impact the wilderness characteristics of designated and proposed wilderness areas that are in the immediate vicinity of the proposed withdrawal parcels.

Mining activities that would occur under a no-withdrawal scenario that are far from designated or proposed wilderness would have a minor short-term impact to wilderness resources. Mining activities in close proximity to designated or proposed wilderness boundaries would have a moderate short-term impact to the wilderness resources of naturalness, opportunities for solitude, and opportunities for primitive and unconfined recreation.

Although designated wilderness areas such as Mount Trumbull and Mount Logan Wilderness areas are not within or immediately adjacent to the proposed withdrawal, indirect impacts under Alternative A could occur, such as noise. Noise associated with mining activity would detract from the wilderness definition of land as possessing a ‘natural’ and ‘undeveloped’ characteristic. Thus, Alternative A would have minor, long-term indirect impacts to nearby wilderness areas such as Mount Trumbull or Mount Logan Wilderness areas.

Cumulative Impacts

The cumulative effects analysis area for Alternative A includes the proposed withdrawal area, the proposed wilderness area, and the three designated wilderness areas. Past, present, and reasonably foreseeable future projects may contribute to the indirect impacts to the characteristics of wilderness resources: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.

Past projects include the following: fuels reduction around the Tusayan airport; wildlife waters development on all three parcels; issuance of special recreation permits for jeep and biking tours on the North and East parcels; livestock grazing; small mineral materials pits on the North Parcel; and vegetation restoration. In addition to these site-specific projects, other past actions and events include homesteading and community settlement in the early 1900s–1930s; trail and road/highway construction; the creation of the specially designated national park and national monuments and the subsequent tourism that increased visitation to the area; drought and wildfires; and mineral exploration and extraction.

Existing projects and events that are present in the proposed withdrawal area include special recreation permits for OHV use; dispersed recreation; and mineral development.

Reasonably foreseeable future projects and events for the proposed withdrawal areas include the continuance of regional and community population growth; continuance of livestock grazing; land tenure adjustments by the BLM and Forest Service; recreation, particularly OHV use increases; the Kaibab National Forest Plan Revision and Travel Management Plan; and vegetation and wildlife restoration projects.

4.13.4 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

A withdrawal scenario that would result in approximately 11 uranium exploration projects, 11 uranium mines, 106,225 ore haul trips, and 6.4 miles of new roads and power lines, resulting in approximately 152 acres of disturbed landscape, would not result in any direct impacts to designated and proposed wilderness areas. However, the withdrawal from the Mining Law (except for valid existing rights) under Alternative B would result in an 98% decrease in uranium exploration projects, a 63% decrease in uranium mines, a 77% decrease in ore haul trips, and a 71% decrease in miles of new roads and power lines as compared to Alternative A. The decrease in mining-related activity under Alternative B would result in an indirect, but beneficial impact to wilderness resources.

The valid existing mining rights that would continue to operate under Alternative B would still have the potential to impact the wilderness resources of the proposed and designated wilderness areas adjacent to the proposed withdrawal area as described under Alternative A. However, Alternative B's mineral withdrawal would result in less mining than Alternative; therefore, fewer mining activities would occur simultaneously, thus potentially reducing the magnitude of impacts to wilderness resources.

Cumulative Impacts

The cumulative effects analysis area identified for Alternative B's cumulative impacts to wilderness resources is the same as described for Alternative A.

Cumulative impacts under Alternative B would be similar in magnitude to Alternative A. For this analysis, although there is a measurable difference in anticipated mining activity under the proposed RFD scenario, the reduction in cumulative impacts as a result of the withdrawal of all mining activity when compared to Alternative A would not be substantially less so as to warrant a separate discussion here for Alternative B.

4.13.5 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Direct and Indirect Impacts

A withdrawal scenario that would result in approximately 207 uranium exploration projects, 18 uranium mines, 184,065 ore haul trips, and 12.1 miles of new roads and power lines, resulting in approximately 508 acres of disturbed landscape, would not result in any direct impacts to designated and proposed wilderness areas. However, the withdrawal from the Mining Law (except for valid existing rights) under Alternative C would result in an 71% decrease in uranium exploration projects, a 40% decrease in uranium mines, a 42% decrease in ore haul trips, and a 45% decrease in miles of new roads and power lines as compared to Alternative A. The decrease in mining-related activity under Alternative C would result in an indirect, but beneficial impact to wilderness resources.

The valid existing mining rights that would continue to operate under Alternative C would still have the potential to impact the wilderness resources of the proposed and designated wilderness areas adjacent to the proposed withdrawal area as described under Alternative A. However, Alternative C's mineral withdrawal would result in less mining than Alternative A; therefore, fewer mining activities would occur simultaneously, thus reducing the magnitude of impacts to wilderness resources.

Cumulative Impacts

The cumulative effects analysis area identified for Alternative C's cumulative impacts to wilderness resources is the same as described for Alternative A.

Cumulative impacts under Alternative C would be similar in magnitude to Alternative A. For this analysis, although there is a measurable difference in anticipated mining activity under the proposed RFD scenario, the reduction in cumulative impacts as a result of the withdrawal of all mining activity when compared to Alternative A would not be substantially less so as to warrant a separate discussion here for Alternative C.

4.13.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

A withdrawal scenario that would result in approximately 431 uranium exploration projects, 26 uranium mines, 273,025 ore haul trips, and 19.1 miles of new roads and power lines, resulting in approximately 914 acres of disturbed landscape, would not result in any direct impacts to designated and proposed wilderness areas. However, the withdrawal from the Mining Law (except for valid existing rights) under Alternative D would result in an 40% decrease in uranium exploration projects, a 13% decrease in uranium mines, a 14% decrease in ore haul trips, and a 14% decrease in miles of new roads and power lines as compared to Alternative A. The decrease in mining-related activity under Alternative D would result in an indirect, but beneficial impact to wilderness resources.

The valid existing mining rights that would continue to operate under Alternative C would still have the potential to impact the wilderness resources of the proposed and designated wilderness areas adjacent to the proposed withdrawal area as described under Alternative A. However, Alternative D's mineral withdrawal would result in less mining than Alternative A; therefore, fewer mining activities would occur simultaneously, thus reducing the magnitude of impacts to wilderness resources.

Cumulative Impacts

The cumulative effects analysis area identified for Alternative D's cumulative impacts to wilderness resources is the same as described for Alternative A.

Cumulative impacts under Alternative D would be similar in magnitude to Alternative A. For this analysis, although there is a measurable difference in anticipated mining activity under the proposed RFD scenario, the reduction in cumulative impacts as a result of the withdrawal of all mining activity when compared to Alternative A would not be substantially less so as to warrant a separate discussion here for Alternative D.

4.14 WILDERNESS CHARACTERISTICS

4.14.1 Introduction

The wilderness characteristics impact analysis is an assessment of potential impacts on lands with wilderness characteristics, lands managed to maintain wilderness characteristics, and lands managed as proposed wilderness that could result from the withdrawal of mineral exploration and development activities as described for each alternative in Chapter 2 of this FEIS.

As described in Section 3.14, there are lands possessing wilderness characteristics in the Grand Canyon watershed. There are lands with wilderness characteristics within the North and East Parcels. There are no lands with wilderness characteristics in the South Parcel. There are two areas managed to maintain wilderness characteristics within the North Parcel. There are no areas managed to maintain wilderness characteristics within the East and South parcels.

There is a wilderness proposal for nearly 1 million acres that is pending for Grand Canyon National Park. While awaiting further action from the Secretary, the Park continues to manage the proposed wilderness as wilderness.

There are no KNF lands managed to maintain wilderness characteristics within or adjacent to the proposed withdrawal.

4.14.2 Impact Assessment Methodology and Assumptions

Analysis of potential impacts to lands managed to maintain wilderness characteristics involves determining whether potential impacts of the proposed mineral withdrawal would result in changes to any of the three tangible qualities of wilderness that make up the description of lands managed to maintain wilderness characteristics, as discussed above in Section 3.14.2. BLM lands allocated in the Arizona Strip Field Office ROD/RMP (BLM 2008b) that are that possess or are managed to maintain wilderness characteristics are not withdrawn lands, nor are they managed the same as Congressionally designated wilderness.

As discussed in Section 4.14.1, Grand Canyon National Park's proposed wilderness is managed as wilderness. For the purposes of this impact analysis, NPS proposed wilderness is treated the same as BLM lands managed to maintain wilderness characteristics. Similarly, areas within the Park that are proposed potential wilderness are also managed by the Park as wilderness. Therefore, NPS proposed potential wilderness are analyzed the same as BLM lands managed to maintain wilderness characteristics.

To analyze potential impacts on wilderness characteristics, RFD scenarios of uranium mining activities provide the basis for determining what level of development scenarios would occur under each alternative for the proposed withdrawal (see Appendix B). Further NEPA analysis would be required if the operator modifies its operating plan.

Effects are quantified where possible (i.e., acreages of surface disturbance that the RFD predicts to occur under each alternative). In the absence of quantitative data, best professional judgment was used. Impacts are sometimes described using a range of potential impacts or in qualitative terms, if appropriate. Tables 4.14-1 and 4.14-2 provide thresholds and descriptions used during analysis for wilderness characteristics impacts.

Table 4.14-1. Magnitude and Degrees of Effects on Wilderness Characteristics

Attribute of Effect	Description Relative to Wilderness Characteristics
No Impact	Impacts would have no discernible effect on wilderness characteristics. Natural conditions would prevail. There would be no permanent visual improvements or human occupation. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation.
Minor	Impacts would be slightly detectable within limited areas of lands managed to maintain wilderness characteristics. Natural conditions would predominate. There would be no permanent visual improvements or human occupation. While there might be short-term impacts within the lands managed to maintain wilderness characteristics, over the long term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.
Moderate	Impacts would be readily apparent within limited areas of lands managed to maintain wilderness characteristics. It would be apparent that man has altered natural conditions within such areas. There would be no permanent visual improvements or human occupation. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted in limited areas and during limited times of the year.
Major	Impacts would substantially alter the lands managed to maintain wilderness characteristics throughout the area. Natural conditions would have been substantially altered by man. Improvements made by man, while not permanent, would be long term and become part of the landscape. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted within the lands managed to maintain wilderness characteristics.

Table 4.14-2. Duration Definition of Effects on Wilderness Characteristics

Duration	
Temporary	Up to 1 year
Short-term	1 to 5 years
Long-term	Greater than 5 years

4.14.3 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

Under Alternative A, a no-withdrawal scenario is anticipated to involve approximately 728 uranium exploration projects, 30 uranium mines, 317,505 ore haul trips, and 22.4 miles of new roads and power lines, resulting in approximately 1,321 acres of disturbed landscape over 20 years, and would have a direct, major impact to wilderness characteristics, both on lands possessing wilderness characteristics and lands managed to maintain wilderness characteristics. The mining activities of a no-withdrawal scenario predicted under Alternative A would reduce the land's ability to provide a high degree of naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation. Indirect impacts to wilderness characteristics would result when the mining-related activity that would be expected under Alternative A occurs on lands adjacent to those that possess or are managed to maintain wilderness characteristics, since activities such as noise and dust or changes to the characteristic visual landscape may extend beyond the physical footprint of the activity.

The high degree of naturalness of the lands managed to maintain wilderness characteristics would be disrupted in the immediate vicinity of the mine during the mining activity if Alternative A were implemented. The imprint of human activity would not be substantially unnoticeable in the immediate vicinity of mining activity, one of the measures used to define wilderness characteristics. This imprint, or surface disturbance, is predicted to last 5 years. This disturbance could last longer than the approximately 5 years per mine, as defined in the RFD, should the life of the mine be extended. Further NEPA analysis would be required if the operator modifies its operating plan. However, the imprint of human activity would be substantially unnoticeable from other far-removed areas of lands managed to maintain wilderness characteristics.

The outstanding opportunity for solitude the lands managed to maintain wilderness characteristics present would also be disrupted in the immediate vicinity of the mining activity if Alternative A were implemented. Sights, sounds, and evidence of other people would become more frequent during the life of the mine under a no-withdrawal scenario. Visitors would still have opportunities to isolate themselves from others but may be forced to visit other areas of lands managed to maintain wilderness characteristics if the predicted mining activity under Alternative A occurred within or adjacent to lands possessing or managed to maintain wilderness characteristics.

The outstanding opportunities for primitive and unconfined recreation that the lands possessing or managed to maintain wilderness characteristics within the proposed withdrawal area possess would be disrupted in the immediate vicinity of the mining activity if Alternative A were implemented. New mines would develop approximately 22.4 miles of new roads, which would enable motorized and mechanized recreational use, uses that are not consistent with outstanding opportunities for primitive and unconfined recreation.

Similar to the analysis presented in Section 4.13.3, potential impacts to lands possessing or managed to maintain wilderness characteristics would depend on placement and density of specific exploration and mining operations and thus become project specific. Mining activities that occur closer to lands possessing or managed to maintain wilderness characteristics would have a greater potential impact than those occurring farther away. Portions of the proposed withdrawal are adjacent to wilderness and lands possessing or managed to maintain wilderness characteristics, and under the 1984 Arizona Wilderness Act, the lands adjacent to designated Wilderness are available for mining activity. Similarly, lands adjacent to lands possessing or managed to maintain wilderness characteristics would also be available for mining activity. Resource protection measures, including measures to decrease impacts to lands managed to maintain wilderness characteristics, would be considered by BLM during project-specific plans of operation and any subsequent required NEPA analysis that would accompany such projects.

Mining activities that are located far from lands possessing or managed to maintain wilderness characteristics would have a minor impact to wilderness characteristics. The high degree of naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation would remain unchanged on lands far from mining activities under Alternative A. The impact to wilderness characteristics on lands in close proximity to mining activities would be major to moderate since the mining activity would result in disruptions to the high degree of naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation currently available on lands possessing or managed to maintain wilderness characteristics.

Portions of the proposed withdrawal border Grand Canyon National Park; therefore, it is possible that sounds from the mine exploration, development, and reclamation/closure activities could be audible within the Park, impacting lands possessing or managed to maintain wilderness characteristics. Similarly, it is possible that federal land users north of the proposed withdrawal area (such as Grand Staircase–Escalante National Monument) would have their recreation experience and setting impacted from sounds from mines, explorations, and haul traffic. Since the RFD predicts up to 30 mines over 20 years under Alternative A, the indirect impact would be moderate and long term.

Cumulative Impacts

The cumulative impact analysis area for Alternative A includes the proposed withdrawal area, proposed wilderness areas, adjacent lands with wilderness characteristics, and adjacent lands managed to maintain wilderness characteristics. Past, present, and reasonably foreseeable future projects may contribute to the cumulative impacts to the land’s wilderness characteristics of a high degree of naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation. Impacts to wilderness characteristics, when viewed incrementally with other past, present, and reasonably foreseeable future actions, would result in minor, indirect impacts. The high percentage of federally managed land in the region surrounding the proposed withdrawal (including BLM field offices in Washington and Kane counties, Utah) presents a unique density of lands with of wilderness characteristics. The incremental and additive impact would grow in magnitude over time since increases in activity generally result in decreases to the land’s wilderness characteristics.

Past projects include the following: fuels reduction around the Tusayan airport; wildlife waters development on all three parcels; issuance of special recreation permits for jeep and biking tours on the North and East parcels; livestock grazing; small mineral materials pits on the North Parcel; and vegetation restoration. In addition to these site-specific projects, other past actions and events include homesteading and community settlement in the early 1900s–1930s; trail and road/highway construction; the creation of the specially designated areas such as national parks, national monuments, and wilderness areas and the subsequent tourism that increased visitation to the area; drought and wildfires; and mineral exploration and extraction.

Existing projects and events that are present in the proposed withdrawal area include special recreation permits for OHV use; dispersed recreation; and mineral development. The high percentage of federally managed land in the region surrounding the proposed withdrawal (including BLM field offices in Washington and Kane counties, Utah) presents a unique density of lands with of wilderness characteristics.

Reasonably foreseeable future projects and events for the proposed withdrawal area include the continuance of regional and community population growth; continuance of livestock grazing; land tenure adjustments by the BLM and Forest Service; recreation, particularly OHV use increases; the Kaibab National Forest Plan Revision and Travel Management Plan; mineral development; and vegetation and wildlife restoration projects.

4.14.4 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

A withdrawal scenario that would result in approximately 11 uranium exploration projects, 11 uranium mines, 106,225 ore haul trips, and 6.4 miles of new roads and power lines, resulting in approximately 152 acres of disturbed landscape, would have a direct, moderate impact to wilderness characteristics, both on lands possessing wilderness characteristics and lands managed to maintain wilderness characteristics. However, when compared to the No Action Alternative A, the withdrawal from the Mining Law (except for valid existing rights) under Alternative B would result in a 98% decrease in uranium exploration projects, a 63% decrease in uranium mines, a 77% decrease in ore haul trips, and a 71% decrease in miles of new roads and power lines. The decrease in mining-related activity under Alternative B would result in an indirect but beneficial impact to wilderness characteristics since fewer changes to existing lands possessing or managed to maintain wilderness characteristics would result. The Proposed Action would have the greatest potential of all alternatives, including the No Action, to not change the existing wilderness characteristics since Alternative B would withdraw the greatest amount of total acreage of all the alternatives.

Alternative B's potential to impact the land's wilderness characteristics is analyzed using the same measures described under Alternative A: the potential for the withdrawal to change the land's ability to provide a high degree of naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation. Since less mining is anticipated under Alternative B than Alternative A, fewer mining activities would occur simultaneously, thus potentially reducing the magnitude of impacts to wilderness characteristics under Alternative B.

Cumulative Impacts

The cumulative impacts assessment area identified for analysis of Alternative B's cumulative impacts to wilderness characteristics is the same as described for Alternative A.

Cumulative impacts under Alternative B would be similar in magnitude to Alternative A. The reduction in cumulative impacts as a result of the withdrawal when compared to Alternative A would not be substantially less so as to warrant a separate discussion here for Alternative B.

4.14.5 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Direct and Indirect Impacts

A withdrawal scenario that would result in approximately 207 uranium exploration projects, 18 uranium mines, 184,065 ore haul trips, and 12.1 miles of new roads and power lines, resulting in approximately 508 acres of disturbed landscape, would have a direct impact to wilderness characteristics, both on lands possessing wilderness characteristics and lands managed to maintain wilderness characteristics. However, when compared to the No Action Alternative A, the withdrawal from the Mining Law (except for valid existing rights) under Alternative C would result in a 71% decrease in uranium exploration projects, a 40% decrease in uranium mines, a 42% decrease in ore haul trips, and a 45% decrease in miles of new roads and power lines. The decrease in mining-related activity under Alternative C would result in an indirect but beneficial impact to wilderness characteristics since fewer changes to existing lands possessing or managed to maintain wilderness characteristics would result.

Alternative C's potential to impact lands managed to maintain wilderness characteristics within and adjacent to the proposed withdrawal area would be similar to that of Alternative A. However, less mining is anticipated under Alternative C than Alternative A; therefore, fewer mining activities would occur simultaneously, thus potentially reducing the magnitude of impacts to wilderness characteristics.

Cumulative Impacts

The cumulative impacts assessment area identified for analysis of Alternative C's cumulative impacts to wilderness characteristics is the same as described for Alternative A.

Cumulative impacts under Alternative C would be similar in magnitude to Alternative A. The reduction in cumulative impacts as a result of the withdrawal when compared to Alternative A would not be substantially less so as to warrant a separate discussion here for Alternative C.

4.14.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

A withdrawal scenario that would result in approximately 431uranium exploration projects, 26 uranium mines, 273,025 ore haul trips, and 19.1 miles of new roads and power lines, resulting in approximately 914 acres of disturbed landscape, would have a direct impact to wilderness characteristics, both on lands possessing wilderness characteristics and lands managed to maintain wilderness characteristics. However, when compared to the No Action Alternative A, the withdrawal from the Mining Law (except for valid existing rights) under Alternative D would result in a 40% decrease in uranium exploration projects, a 13% decrease in uranium mines, a 14% decrease in ore haul trips, and a 14% decrease in miles of new roads and power lines. The decrease in mining-related activity under Alternative C would result in an indirect but beneficial impact to wilderness characteristics since fewer changes to existing lands possessing or managed to maintain wilderness characteristics would result.

Alternative D's potential to impact lands managed to maintain wilderness characteristics within and adjacent to the proposed withdrawal area would be similar to that of Alternative A. However, less mining is anticipcated under Alternative D than Alternative A; therefore, fewer mining activities would occur simultaneously, thus potentially reducing the magnitude of impacts to wilderness characteristics.

Cumulative Impacts

The cumulative impacts assessment area identified for analysis of Alternative D's cumulative impacts to wilderness characteristics is the same as described for Alternative A.

Cumulative impacts under Alternative D would be similar in magnitude to Alternative A. The reduction in cumulative impacts as a result of the withdrawal when compared to Alternative A would not be substantially less so as to warrant a separate discussion here for Alternative D.

4.15 RECREATION RESOURCES

This section presents potential impacts of the proposed withdrawal and alternatives on recreation resources. The impacts are determined through potential changes in the recreation resource impact indicators identified in Chapter 3. Recreation activities are interrelated and connected to other natural resources and resources uses and wilderness character; therefore, changes in allowable uses and restrictions on other resources can have influences on recreation. Recreation resource impact indicators are evaluated based on the following parameters, which could change if the proposed withdrawal were implemented:

- visitor use by activity;

- acres within the ROS settings and proposed wilderness,
- desired semi-primitive and primitive recreation experiences; and
- miles or number of roads that provide access to recreation sites that are currently designated in the proposed withdrawal area.

Recreational experiences and the potential attainment of a variety of beneficial outcomes are vulnerable to any management action that would alter the settings and opportunities in a particular area. The recreation settings are based on a wide variety of attributes, including remoteness, the degree of human modification to the natural environment, evidence of other users, restrictions and controls on surface-disturbing activities, and level of motorized vehicle use. Actions, such as a mineral withdrawal, that alter such features within a particular portion of the proposed withdrawal area could affect the capacity of that landscape setting to provide appropriate recreation opportunities and beneficial outcomes.

As explained in Chapter 3, the analysis area is essentially the entire proposed withdrawal area, where sights and sounds related to mineral development (except valid existing rights) would be experienced by the visitor; or conversely, would not be experienced by the visitor if a mineral withdrawal were implemented and the activity related to mineral development did not occur. To assess changes to recreation opportunities and settings resulting from the implementation of the proposed withdrawal, this analysis uses information from other resources analyzed in this EIS, such as noise and visual resources.

The analysis considers the projected increase in sound at select noise-sensitive receptors within and surrounding the area that would occur under a no-withdrawal scenario or would not occur under a withdrawal scenario. It assumes that the greater the distance the recreationist has to travel to get away from the sound, the greater the impact to the recreational experience.

Visual simulations in conjunction with the visual resource contrast analysis are used to estimate changes to the viewshed from select Key Observation Points throughout the analysis area. It is assumed for this analysis that the greater the degree of contrast, the more visible a mining development/activity will be on the landscape, and the greater the impact to the recreational activities, settings, and experiences. See Sections 4.10, Soundscapes, and 4.9, Visual Resources, for more detailed information on visual resources and noise analysis methodologies and results.

Further, this analysis assumes that indirect impacts could occur in the areas outside the proposed withdrawal, such as Grand Canyon National Park, Vermilion Cliffs National Monument, and designated and proposed wilderness areas. These impacts would be minor and limited to visual resources, soundscapes, existence and use values, and temporal bounds.

Indirect impacts to recreation may occur outside the withdrawal area due to the major tourism and visitation (5 million plus per year in Grand Canyon National Park alone) experienced in the region. The region is known for its scenic beauty, which could be affected if existing uranium mining activity changes in areas near or within the same viewshed as the above mentioned specially designated areas, monuments, and wilderness areas. The potential changes in the visual character and associated mining traffic could impact recreation in varying degrees, depending on recreation activity, distance, topography, and preferences of individual visitors (refer to Section 4.9 for visual impacts). Further, it is recognized that while primitive recreation ROS settings may not exist within the proposed withdrawal area, there are adjacent areas that include a primitive setting or undeveloped setting.

4.15.1 Impact Assessment Methodology and Assumptions

The analysis to determine potential impacts to recreation is based in part on visitor use reporting statistics from the Arizona Strip District Office and RMIS; the Kaibab National Forest's Tusayan Ranger District

NVUM; and Grand Canyon National Park backcountry visitation data. In addition to the visitation tracking numbers, spatial/GIS information was also used in this analysis and includes wilderness characteristics boundaries, special designations, transportation inventory, ROS settings, historic and recreational trails, and known cultural sites. As outlined in Chapter 3, the changes (based on a reasonably foreseeable development scenario) to the resource condition indicators provide the basis for assessing impacts to recreation. The impact analysis is also based on review of existing literature and information provided by resource team experts in the BLM, NPS, Forest Service, and other agencies.

To analyze potential impacts to recreation resources, RFD scenarios of uranium mining activities provide the basis for determining what level of development scenarios would occur under each alternative in Appendix B.

Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Tables 4.15-1 and 4.15-2 below describe qualitative impact terms used to determine recreation impacts.

The following assumptions are included when analyzing the environmental consequences the proposed withdrawal alternatives would have on recreation resources:

- Recreation opportunities in adjacent primitive ROS settings and adjacent undeveloped areas could be impacted by uranium activities that are visible from a particular viewshed.

Table 4.15-1. Magnitude and Degrees of Effects on Recreation Resources

Attribute of Effect	Description Relative to Recreation Resources
No Impact	The action would not produce obvious changes to the recreation setting, opportunity or desired experiences.
Minor	Impacts that would retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.
Moderate	Impacts that would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity by eliminating the desired recreation experiences.
Major	Impacts that would create a high degree of change in the recreation setting and would dominate the recreation opportunity by eliminating the desired recreation experiences.

Table 4.15-2. Duration Definition of Effects on Recreation Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

4.15.2 Incomplete or Unavailable Information

As stated in Table 3.15-2, some recreation sites analyzed in this EIS do not report visitation data. Coordination with BLM Recreation Planners, Forest Service Recreation Specialists, and NPS Outdoor Recreation Planners was conducted if information was incomplete or unavailable. Regional expertise from those familiar with the recreation sites and trends also assisted in providing information for qualitative analysis.

4.15.3 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

The landscape and existing roads and trails within the study area could be altered once the 6-month emergency withdrawal expires, and there could be continuing changes to the visual character or levels of noise. Existing BLM and Forest Service surface management regulations would provide the standards with which mining activities must comply. These standards would not preclude impacts to recreation, however. The presence of mining activities in itself can impact recreation. New roads may be created (which could benefit some forms of recreation opportunity, as discussed below), and mining activities could occur on lands that were previously undeveloped if the No Action Alternative were selected. Indirect effects on recreation users of the Grand Canyon watershed (including river-running) under Alternative A would include minor long-term changes to the recreation setting and experience. Further analyses of the potential impacts to the water quality of the Grand Canyon watershed are provided in Section 4.4, Water Resources.

Impacts to Visitor Use

The no-withdrawal scenario under Alternative A has the potential to impact recreation visitor use on the public lands within the proposed withdrawal area. The direct impact would be moderate due to the changes to existing recreation settings and experience that would come with approximately 728 uranium exploration projects, 30 uranium mines, 317,505 ore haul trips, and 22.4 miles of new roads and power lines, resulting in approximately 1,321 acres of disturbed landscape over 20 years.

Mining-related activity under a no-withdrawal scenario has the potential to create new roads that could attract more users to explore areas that were previously inaccessible to vehicles. This may increase the amount of visitors to all three withdrawal parcels, particularly to the North and South parcels, as these two parcels include greater potential for uranium presence than the East Parcel (USGS 2010b); therefore, the possibility of new roads would be greater in the North and South parcels. These new roads, if constructed, would only exist for the life of the mine, typically 3 to 5 years, at which point the roads would be closed and reclaimed. Further NEPA analysis would be required if the operator modifies its operating plan. Therefore, the creation of new roads would not be a long-term impact to recreation.

Because of the proposed withdrawal area’s remote and relatively undeveloped character, many users seek out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region. The likelihood of impacts to these types of recreation opportunities would increase if Alternative A is selected, as the presence of new roads in previously non-roaded areas, heavy-haul trucks, and mining facilities could increase under Alternative A’s no-withdrawal scenario. The impacts to recreation could be adverse as a result of the mining activities’ potential to alter the existing recreation setting and opportunity. Although a no-withdrawal scenario under Alternative A would result in an increase in existing mineral activity, the mines themselves would be relatively spaced out and separated, compared with the overall acreage of the available BLM and Forest Service lands; therefore, the impact to visitor use would be classified as minor.

Because of the high number of visitors that travel to Grand Canyon National Park (up to 5 million per year), impacts of Alternative A’s no-withdrawal scenario (which includes uranium exploration and development) to visitor use are not eliminated, particularly in the South Parcel, where the number of visitors far exceeds that of the North and East Parcel. Alternative A’s no-withdrawal scenario would result in the presence of uranium mining activities such as heavy-haul trucks, noise, and visual intrusion. These mining activities could change the typical recreation setting and experience for visitor use of the Grand Canyon region. Impacts to visitor use on certain sites may be moderate, depending on the mining activity's proximity to highly used areas. The South Parcel contains the gateway to Grand Canyon National Park, and the users passing through the South Parcel experience different recreation settings than would be experienced in the North and East parcels. The overall impact to visitor use would be minor since each uranium exploration would only affect 1.1 acres and each uranium development would affect only approximately 20 total acres in the proposed withdrawal area. Further, the majority of the 5 million visitors to Grand Canyon National Park visit the South Rim, in the developed Grand Canyon Village, where the impacts of mining-associated activity would be minor. Impacts from mining haul trucks to Grand Canyon visitor traffic along SR 64 would result in minor impacts and interactions but could be long term since the duration of the mines are estimated at 7 years.

Impacts to Recreation Opportunity

Alternative A's no-withdrawal scenario forecasts up to 728 exploration projects could occur, and of these explorations, 30 mines could be developed (including existing and new mines). The overall ground disturbance expected under the Alternative A, in terms of acreage, is small, compared with the recreation opportunity acreage in the region as a whole. The nexus for recreation impacts from uranium mining activity lies not in ground disturbance acreages but in terms of new road creation and the mining activity presence that would accompany Alternative A's no-withdrawal scenario. In the long term, the impacts associated with new road creation would be eliminated once the roads are closed and reclaimed back to their natural condition. Further NEPA analysis would be required if the operator modifies its operating plan.

As Chapter 3 describes, driving for pleasure and sightseeing are among the most popular recreational activities in the proposed withdrawal parcels. Alternative A's no-withdrawal scenario would require up to 22.4 miles of temporary new roads to support mine operations, if the mines were constructed. This increase in roads, if made available to the public, could increase the recreational setting available for those types of recreational experiences that center on road travel, such as sightseeing, driving for pleasure, and casual OHV use in the short term; once the mines are closed, these roads would be reclaimed. Conversely, with the new roads would come increased heavy-haul trucks in both amount and frequency. The increase in activity associated with the 30 new mines, increase in heavy-haul trucks, increase in noise, and 22.4 miles of new roads could affect the recreational experiences, although the impact would be minor. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the new mines, roads, and increase in haul trips would not occur simultaneously. Table 4.15-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized settings within the proposed withdrawal area. Impacts to recreation sites outside the withdrawal area (those sites requiring access from the withdrawal area, as identified in Table 3.15-2) would be indirect. Up to 19 recreational sites in Alternative A's proposed withdrawal area may be impacted under Alternative A's no-withdrawal scenario.

Grand Canyon National Park specifically manages areas such as the southern portion of Kanab Plateau and Marble Platform (both adjacent to the proposed withdrawal area) to maintain undeveloped character; similar to ROS primitive settings used by BLM and Forest Service (see Appendix J). NPS zoning management areas do not apply to activities on adjacent land. However, users of NPS's backcountry management zones may experience minor impacts to the recreation opportunity under Alternative A's no-withdrawal scenario if the mineral exploration and development occur in visible or nearby areas to backcountry management zones. This impact would be similar for all alternatives discussed below.

Table 4.15-3. Recreation Sites Occurring in ROS Settings

Withdrawal Area	Recreation Site	ROS Setting	Alternative A	Alternative B	Alternative C	Alternative D
East Parcel	House Rock Valley Overlook/Interpretive Site	RN	×	×	×	×
East Parcel	Navajo Trail	SPM	×	×		
East Parcel	Soap Creek	SPNM	×	×	×	×
East Parcel	Rider Canyon	SPNM	×	×	×	×
East Parcel	North Canyon Creek	SPM	×	×		
East Parcel	Badger Creek	RN	×	×	×	×
East Parcel	Dominquez-Escalante Interpretive Site	RN	×	×		
East Parcel	Condor Interpretive Site	RN	×	×		
North Parcel	Hack Canyon	RN	×	×	×	×
North Parcel	Swapp Trail	RN	×	×	×	
North Parcel	Gunsight Point	RN	×	×	×	×
North Parcel	Hatch Cabin	SPNM	×	×	×	×
North Parcel	Rock Canyon	SPM	×	×		
South Parcel	Ten-X Family Campground	RN	×	×	×	
South Parcel	Charlie Tank Group Camp Ground	RN	×	×		
South Parcel	Tusayan Bike Trails	RN	×	×	×	×
South Parcel	Arizona Trail	RN	×	×	×	
South Parcel	Red Butte	SPNM	×	×	×	
South Parcel	Russell Tank Fishing Parking Area	RN	×	×		
Totals			**19**	**19**	**13**	**8**

Sources: BLM and Forest Service ROS settings with a GIS recreation data overlay.

Notes: RN = Roaded Natural; SPM = Semi-primitive Motorized; SPNM = Semi-primitive Non-motorized.

Impacts to Recreation Settings and Experiences

There are 19 recreation sites within the proposed withdrawal area. The management of these sites is dependent on who manages the land. The majority of the 19 recreation sites are managed by the BLM (refer to Table 3.15-2 for recreation sites overview), but the Forest Service and NPS also manage recreational sites and settings within and adjacent to the proposed withdrawal areas. (Note that NPS does not manage recreation sites within the proposed withdrawal area, but many recreation experiences on NPS land listed in Table 3.15-2 require access via the proposed withdrawal areas.) It is important to note that desired recreation experiences of users would be commensurate with the multiple-use mandates of the land and their respective recreation opportunity settings, i.e., users of roaded natural areas expect modifications to the landscapes, and users of semi-primitive areas expect little to no modifications to the landscape.

As Figure 3.15-1 illustrates, particularly in the North Parcel, those recreation sites that occur within the proposed withdrawal boundary tend to be concentrated in areas at canyon entrances or canyon overlooks, where the desired recreation setting and experience would be remoteness with high scenic quality (refer to Section 4.9, Visual Resources, for impacts to scenic quality). Under Alternative A's no-withdrawal scenario, there could be a high possibility of mineral development in these areas. Recreation settings and experiences could be impacted at individual sites.

The East Parcel has the fewest mining claims of all the three proposed withdrawal parcels. The Colorado River is relatively easy to access, compared with other reaches within the Park, and House Rock Valley serves as a gateway to other North Rim and Arizona Strip attractions such as Jacob Lake, Vermilion Cliffs National Monument, and the Kaibab Plateau, meaning that public users will pass through House Rock Valley en route to other destinations, primarily on paved U.S. 89A (BLM 2009e). Therefore, even a small mineral development presence may impact recreation settings and experiences in the East Parcel, particularly for users who venture off U.S. 89A; however, these impacts would be minimal. This is because the impacts associated with mining- haul traffic, visual and noise intrusions, and increased roads would be compatible with the current roaded-natural and semi-primitive settings. Impacts to recreation settings in semi-primitive non-motorized areas (canyon entrances such as Soap Creek, Rider, North and Badger) from uranium mining would be moderate.

Figure 3.15-1 shows the concentration of recreation sites on the South Parcel along the SR 64 corridor. The impacts to recreation would be moderate in the South Parcel since mineral development would be precluded in areas near campgrounds and population centers such as the town of Tusayan. Alternative A's no-withdrawal scenario potential mineral development within the South Parcel could still have impacts to recreation, particularly to activities that take place on the rolling terrain dominated by juniper trees such as hunting, hiking, mountain biking, and nature study. This same terrain would also serve as sound and visual barriers to the contrast of mineral exploration and development, decreasing the impact to the settings and experiences.

Section 4.9.2 of the EIS discusses Alternative A's impacts from mining-associated activity to the visual character, indicating there would be changes to the existing visual character if Alternative A were selected. Therefore, recreation settings and experiences that center on scenic viewing or overlooks could be impacted. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) that are anticipated to occur under Alternative A's no-withdrawal scenario. In addition, the lands with different visual management designations have varying degrees of limits for visual impacts. For example, mineral exploration generally would have a much smaller visual impact than a full mining operation because of the smaller footprint size and shorter time frame. Mining activities that occur closer to observation points and/or in more restrictive visual management designations would have a greater recreation impact than those occurring further away from observation points and/or in less restrictive visual management designations.

The soundscape analysis discussed in Section 4.10.1 indicates that mining-associated activity would result in increases in ambient noise levels in the immediate vicinity of the mine sites and haul roads. Noise levels from exploration, mine development, and reclamation/closure activities would be limited to short durations over a period of a couple months at any one location. However, portions of the proposed withdrawal border Grand Canyon National Park; therefore, it is possible that sounds from the mine exploration, development, and reclamation/closure activities could be audible within the Park, impacting recreation settings and experiences. Similarly, it is possible that recreationists on or near the uranium ore haul route north of the proposed withdrawal area (for example, visitors along U.S. 89 within the Grand Staircase–Escalante National Monument) would experience some diminution in quality of the recreational setting due to the presence of haul traffic (317,505 ore haul trips under Alternative A's no-withdrawal scenario). As discussed in Section 4.10.3, given that a "typical" 300-tpd uranium mine will require twelve to sixteen 25-ton ore haul truck trips per day, it is anticipated that haul truck traffic would constitute a small percentage of the total highway traffic. Nevertheless, this is likely to result in minor and long-term indirect impacts to recreation resources.

Indirect impacts to adjacent NPS backcountry management zones may occur if the mining activity occurs near or within sight of the backcountry management zone.

Cumulative Impacts

The cumulative impacts assessment area identified for analysis of Alternative A's cumulative impacts to recreation resources includes the proposed withdrawal area and the adjacent special designations of Vermilion Cliffs National Monument, Grand Canyon–Parashant National Monument, and Grand Canyon National Park.

Past projects include the following: fuels reduction around the Tusayan airport; wildlife waters development on all three parcels; issuance of special recreation permits for jeep and biking tours on the North and East parcels; livestock grazing; small mineral materials pits on the North Parcel; and vegetation restoration. In addition to these site-specific projects, other past actions and events include homesteading and community settlement in the early 1900s–1930s; trail and road/highway construction; the creation of the specially designated national park and national monuments and the subsequent tourism that increased visitation to the area (visitation to the Grand Canyon increased from the 1950s to the early 1990s during the region's peak uranium mining activity [NPS 1995]); drought and wildfires; and mineral exploration and extraction.

Existing projects and events that are present in the proposed withdrawal area include special recreation permits for OHV use; dispersed recreation; and mineral development.

Reasonably foreseeable future projects and events for the proposed withdrawal areas include the continuance of regional and community population growth; continuance of livestock grazing; land tenure adjustments by the BLM and the Forest Service; recreation, particularly OHV use increases; the Kaibab National Forest Plan Revision and Travel Management Plan; and vegetation and wildlife restoration projects.

Based on the impacts described, Alternative A, if selected, would result in an overall moderate impact to visitor use, recreation opportunity, and recreation settings and experience. This is because the impacts from mining exploration and development that might occur under Alternative A would primarily be indirect and moderate, and even considered cumulatively with the impacts of other past, present and reasonably foreseeable future actions, would not rise beyond a moderate level.

4.15.4 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts: Impacts to Visitor Use

A withdrawal scenario that would result in approximately 11 uranium exploration projects, 11 uranium mines, 106,225 ore haul trips, and 6.4 miles of new roads and power lines, resulting in approximately 152 acres of disturbed landscape, would have a direct, minor impact to visitor use. However, when compared to the No Action Alternative A, the withdrawal from the Mining Law (except for valid existing rights) under Alternative B would result in a 98% decrease in uranium exploration projects, a 63% decrease in uranium mines, a 77% decrease in ore haul trips, and a 71% decrease in miles of new roads and power lines. The decrease in mining-related activity under Alternative B would result in a minor, indirect but beneficial impact to visitors who are seeking out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region. Alternative B's potential to impact recreation visitor use of the public lands within the proposed withdrawal area would be minor. Over the long term (5+ years) of the proposed withdrawal, Alternative B could result in minor increased visitor use as a result of the possibility of new roads' being constructed under Alternative B's withdrawal scenario.

There is some potential for mineral development (valid existing rights) to create new temporary roads (6.4 miles over 20 years), which could allow greater access to more areas and may increase visitor use of these areas in the short term. Mineral development would occur over a 20-year time frame; therefore, the roads would not be built simultaneously, decreasing the potential to impact to visitor use.

Impacts to Recreation Opportunity

Alternative B forecasts that up to 11 explorations could occur, and of these explorations, 11 mines could be developed (including existing and new mines). The overall ground disturbance that would be expected, in terms of acreage, is small, compared with the existing recreation opportunity acreage as a whole. Recreation opportunities that require little to no development, unaltered landscapes, and remoteness would not be affected if Alternative B were implemented.

This is because some users would have a greater value for the landscape if the land precluded mineral development; mining is generally seen as an impact to recreation because it is typically not compatible with dispersed recreational activity. An exception is the increase in new roads that the mineral development of valid existing rights under Alternative B's withdrawal may include, which is compatible with developed recreational opportunities and activities such as scenic driving, as well as access to areas that previously may have been inaccessible by vehicle. However, the new roads would not occur simultaneously and in many cases may be reclaimed in 5 to 7 years; therefore, the long-term impact would be minimal. It is important to note that desired recreation experiences of users would be commensurate with the multiple-use mandates of the land and their respective recreation opportunity settings, i.e., users of roaded-natural areas expect modifications to the landscapes, and users of semi-primitive areas expect little to no modifications to the landscape.

Alternative B would include up to 6.4 miles of new roads to support exploration and development and valid existing rights. This increase in roads would be less than Alternative A. With the new roads would come increased heavy-haul trucks in both amount and frequency. The increase in uranium activity presence and noise that may impact individual sites or areas that would come with the 11 mines, the increase in heavy-haul trucks with 106,225 trips, and 6.4 miles of new roads could impact the recreational opportunities and setting. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the new mines, roads, and increase in haul trips would not occur simultaneously. Table 4.15-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized within the proposed withdrawal area under Alternative B. Up to 19 recreational sites may avoid impacts from mineral exploration and development if Alternative B is implemented, subject to valid existing rights.

Impacts to Recreation Settings and Experiences

Alternative B would result in minor impacts to recreation settings and experiences. This is because mining activity (except for valid existing rights) under Alternative B would represent a 98% decrease in uranium exploration projects, a 63% decrease in uranium mines, a 77% decrease in ore haul trips, and a 71% decrease in miles of new roads and power lines from Alternative A. Alternative B would have up to 10 mines in the North Parcel. Impacts that may result from exploration and development of valid existing rights would still be possible under Alternative B and are discussed above under Impacts to Recreation Opportunity.

The withdrawal scenario for Alternative B within the East Parcel would include no mines. Therefore, Alternative B would have no impacts to recreation resources on the East Parcel since no ground disturbance, new roads, or haul trips would occur.

The withdrawal scenario for Alternative B within the South Parcel would include one mine that is an existing mine. One mine would have a minimal effect on the recreation settings and experiences in the South Parcel. If the mine is located within the viewshed of Red Butte, or near the SR 64 corridor, the impact would be greater than if the mine were located on the eastern portions of the South Parcel, outside the Red Butte viewshed and far from the popular recreation settings along the SR 64 corridor. This is because of Red Butte's visual and cultural resource value as the prominent view of the Coconino Plateau and the higher density of public recreational use on Forest Service lands adjacent to SR 64. The decrease in mining-related activity under Alternative B would result in a minor, indirect but beneficial impact to users who are seeking out and expect solitude and semi-primitive recreation settings and experiences when visiting the Grand Canyon region.

Impacts to recreation settings and experiences related to visual resources would be similar to the moderate impacts discussed under Alternative A. However, the magnitude of impact would be minor as a result of the decrease in amount of allowable mineral development (30 mines versus 11 mines, respectively).

Impacts to recreation settings and experiences related to soundscapes would be similar to the moderate impacts discussed under Alternative A. However, the magnitude of impact would be minor due to the decrease in amount of allowable mineral development (30 mines versus 11 mines, respectively).

Indirect impacts to adjacent NPS backcountry management zones may occur if the mining associated activity occurs nearby or within sight of the backcountry management zone. The decrease in mining-related activity under Alternative B would result in a minor, indirect but beneficial impact to visitors who are seeking out and expect solitude and semi-primitive recreation experiences when visiting NPS backcountry management zones.

Cumulative Impacts

The cumulative impacts assessment area identified for analysis of Alternative B's cumulative impacts to recreation resources is the same as described for Alternative A.

Based on the impacts described, Alternative B, if selected, is anticipated to result in an overall minor impact to visitor use, recreation opportunity, and recreation settings and experience. This is because the impacts from mining exploration and development that might occur under Alternative B would primarily be indirect and on a considerably lesser scale than under Alternative A, and even considered cumulatively with the impacts of other past, present and reasonably foreseeable future actions, would not rise beyond a minor level.

4.15.5 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Direct and Indirect Impacts: Impacts to Visitor Use

A withdrawal scenario that would result in approximately 207 uranium exploration projects, 18 uranium mines, 184,065 ore haul trips, and 12.1 miles of new roads and power lines, resulting in approximately 508 acres of disturbed landscape, would have a direct impact to visitor use. However, when compared to the No Action Alternative A, the withdrawal from the Mining Law (except for valid existing rights) under Alternative C would result in a 71% decrease in uranium exploration projects, a 40% decrease in uranium mines, a 42% decrease in ore haul trips, and a 45% decrease in miles of new roads and power lines. The decrease in mining-related activity under Alternative C would result in an indirect, but beneficial impact to visitors who are seeking out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region.

Existing and potential mining activity under Alternative C's withdrawal scenario would have minor impacts to recreation visitor use of the public lands within the proposed withdrawal area; however, the potential for impacts to recreation is greater than Alternative B because of the smaller overall acreage of the partial withdrawal included in this alternative. Areas with higher concentrations of recreational sites would be included in the partial withdrawal, as Figure 2.4-1 illustrates. Dispersed recreation does occur on lands outside Alternative C's partial withdrawal; however, the recreation opportunities and settings in these areas are not considered high visitor-use areas (BLM 2009b). Visitor-use of U.S. 89A and BLM Road 5 (see Figure 3.15-2) could be impacted by the presence of mineral exploration and development if these facilities presented a contrast to the landscape that can be viewed from these routes.

Impacts to Recreation Opportunity

Alternative C forecasts that up to 207 explorations could occur, and of these explorations, 18 new mines could be developed. The potential mining activity acreage totals of the Alternative C withdrawal parcels are reduced from Alternative B acreage totals. The overall ground disturbance that would be expected with valid existing rights under the Alternative C, in terms of acreage, is small, compared with the existing recreation opportunity acreage as a whole.

Recreation opportunities that require little to no development, unaltered landscapes, and remoteness may actually improve if Alternative C were implemented, compared with Alternative A. This is because many users may have a greater value for the landscape if the land precluded mineral development; mining is generally seen as an impact to many recreation opportunities because it is typically not compatible with dispersed recreational activity. An exception is the increase in new roads that are included under Alternative C's withdrawal scenario, which is compatible with developed recreational opportunities and activities such as scenic driving, as well as access to areas that previously may have been inaccessible by vehicle.

Alternative C would develop up to 12.1 miles of new roads. This increase in roads would be slightly greater than Alternative B. The slight increase in roads available to the public could increase the recreational setting available for those types of recreational pursuits that center on road travel, such as sightseeing, driving for pleasure, and casual OHV use. The RFD scenario would occur over a 20-year time frame; therefore, the new roads would not occur simultaneously and would be reclaimed once mining activities cease.

Conversely, with the new roads would come increased heavy-haul trucks in both amount and frequency. The increase in activity associated with the 18 mines and 184,065 trips and 12.1 miles of new roads could have a minor impact as a result of the decrease in the semi-primitive recreational opportunities and settings available to the public. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the new mines, roads and increase in haul trips would not occur simultaneously. Table 4.15-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized, within the proposed withdrawal area under Alternative C. Up to 16 recreational sites may avoid impacts from mineral exploration and development if Alternative C were implemented, subject to valid existing rights.

Impacts to Recreation Settings and Experiences

Alternative C would reduce mining activity impacts to recreation resources in the proposed withdrawal area when compared to Alternative A. In the North Parcel, recreation resources are concentrated in areas that have multiple resource values, such as unique topography, cultural significance, and high ecological value. The Toroweap Road (BLM Road 109) would also be included in Alternative C's withdrawal area. This road is used by many users heading to the Toroweap Campground and overlook in Grand Canyon National Park. Alternative C would result in fewer impacts to recreation experiences than Alternatives A and D. This is because the scenario is similar to Alternative B but on a smaller acreage. Alternative C would have up to 13 mines in the North Parcel. It is important to note that mineral development would occur over a 20-year time frame; therefore, the new mines, roads, and increase in haul trips would not occur simultaneously and would be reclaimed once mining activities cease. Impacts that may result from exploration and development of valid existing rights would still be possible under Alternative C and are discussed above under Impacts to Recreation Opportunity.

The withdrawal scenario under Alternative C within the East Parcel would include one mine. Up to 28 explorations could occur. Recreation settings and experiences in the East Parcel are evenly distributed among dispersed and developed recreation. The settings are largely based on the views and available access to the Colorado River via multiple side canyons. The partial withdrawal would lessen the impacts to scenic driving and hiking to the Colorado River in many of the highly used areas. Up to 1.2 new miles of road could create more access for developed recreational experiences.

The withdrawal scenario under Alternative C within the South Parcel would include four mines. The partial withdrawal would include areas of the South Parcel that contain well-used recreation settings and experiences, such as camping, hiking, and scenic driving. These settings are popular because of their proximity to SR 64 and the Grand Canyon National Park. The overall surface disturbance of 158 acres expected under Alternative C would likely have little to no impact to recreation.

Under Alternative C, all of the landscapes designated visually sensitive are included in the proposed withdrawal area and removed from most mining activity. Some mining would still occur in the withdrawal area, as described in Alternative B, but the amount is limited. Therefore, Alternative C's visual impacts from mining-associated activity to recreation settings and experiences would be minor.

Impacts to recreation settings and experiences related to soundscapes would be similar to impacts discussed under Alternative B. The decreased overall acreage of Alternative C's proposed withdrawal area may increase the likelihood of impacts, but the impact to recreation settings and experiences would be minor.

Indirect impacts to adjacent NPS backcountry management zones may occur if the mining associated activity occurs near or within sight of the backcountry management zone. The decrease in mining-related activity under Alternative C would result in a minor, indirect but beneficial impact to visitors who are seeking out and expect solitude and semi-primitive recreation experiences when visiting NPS backcountry management zones.

Cumulative Impacts

The cumulative impacts assessment area identified for analysis of Alternative C's cumulative impacts to recreation resources is the same as described for Alternative A.

Based on the impacts described, Alternative C, if selected, is anticipated to result in an overall minor impact to visitor use, recreation opportunity, and recreation settings and experience. This is because the impacts from mining exploration and development that might occur under Alternative C would primarily be indirect and on a considerably lesser scale than under Alternative A, and even considered cumulatively with the impacts of other past, present and reasonably foreseeable future actions, would not rise beyond a minor level.

4.15.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts: Impacts to Visitor Use

Alternative D's potential to impact recreation visitor use of the public lands within the proposed withdrawal area would be minimal and similar to Alternative C; however, the potential for impacts to recreation is greater than Alternative C because of the smaller overall acreage of the withdrawal included in Alternative D. A withdrawal scenario that would result in approximately 431uranium exploration projects, 26 uranium mines, 273,025 ore haul trips, and 19.1 miles of new roads and power lines, resulting in approximately 914 acres of disturbed landscape, would have a direct impact to visitor use. However, when compared to the No Action Alternative A, the withdrawal from the Mining Law (except for valid existing rights) under Alternative D would result in a 40% decrease in uranium exploration projects, a 13% decrease in uranium mines, a 14% decrease in ore haul trips, and a 14% decrease in miles of new roads and power lines. The decrease in mining-related activity under Alternative D would result in an indirect, but beneficial impact to visitors who are seeking out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region. Areas with higher concentrations of recreational sites would be included in the partial withdrawal, as Figure 2.4-4 illustrates. A key difference and between Alternatives C and D, in terms of a greater impacts to visitor use, is that the Toroweap Road is not included in Alternative D's partial withdrawal. Chapter 3 describes the importance of the Toroweap Road; it is the primary route users take when visiting the Toroweap Point campground and overlook, as well as other scenic overlooks and trailheads in Grand Canyon National Park. The presence of mineral exploration and development, if visible from Toroweap Road, could impact visitor use, as well as the recreation settings. Similarly, local and visitor use of U.S. 89A, SR 64, the east entrance to Grand Canyon National Park, and BLM Road 5 (see Figure 3.15-2) could be impacted, although minimally, by the presence of mineral exploration and development that would be included under Alternative D if these facilities presented a contrast to the landscape that is visible from these routes.

Impacts to Recreation Opportunity

Under Alternative D's withdrawal scenario, up to 431 explorations could occur, and 26 mines could be developed. The acreage totals of the Alternative D withdrawal areas are reduced from Alternative B and C acreage totals. However, the overall ground disturbance that would be expected with valid existing rights under the Alternative D, in terms of acreage, is small, compared with the existing recreation opportunity acreage as a whole. Alternative D's withdrawal (see Figures 2.4-5 through 2.4-7) would withdraw from mining exploration and development areas that have high scenic, cultural, and biological value. These withdrawal areas are also commonly used recreational destinations such as hiking trailheads, historic trails, and interpretive sites.

Recreation opportunities that require little to no development, unaltered landscapes, and remoteness could be impacted if Alternative D were implemented. This is because many users may have a greater value for the landscape if the land precluded mineral development; mining is generally seen as an impact to many recreation opportunities because it is typically not compatible with dispersed recreational activity. An exception is the increase in new roads that mineral development may include, which is compatible with developed recreational opportunities and activities such as scenic driving, as well as access to areas that previously may have been inaccessible by vehicle. However, the new roads would not occur simultaneously and would be reclaimed once mining activities cease; therefore, the impact would be minimal.

The recreational opportunity on Toroweap Road could be impacted if Alternative D were implemented since it is not included in the withdrawal parcel. As Figure 3.15-3 illustrates, Toroweap Road is rated as roaded-natural. The presence of mining activity, if visible from the road, would have a minimal impact to recreation opportunity. If mining activities are sited in areas that would not be visible from Toroweap Road, the potential to impact recreational opportunity would be reduced. It is important to note that desired recreation experiences of users would be commensurate with the multiple-use mandates of the land and their respective recreation opportunity settings, i.e., users of roaded-natural areas expect modifications to the landscapes, and users of semi-primitive areas expect little to no modifications to the landscape.

Alternative D's withdrawal scenario would develop up to 19.1 miles of new roads to support exploration and development and valid existing rights. This increase in roads would be the greatest of all the action alternatives. This increase in roads available to the public could increase the recreational setting available for those types of recreational pursuits that center on road travel, such as sightseeing, driving for pleasure, and casual OHV use.

However, with the new roads would come increased heavy-haul trucks in both amount and frequency. The increased activity associated with the 26 mines and 273,025 trips, and 19.1 miles of new roads could have a minor impact as a result of the small decrease in the semi-primitive recreational settings. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the mines, roads, and increase in haul trips would not occur simultaneously.

Table 4.15-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized within the proposed withdrawal area under Alternative D. Up to 10 recreational sites may avoid impacts from mineral exploration and development if Alternative D were implemented, subject to valid existing rights.

Impacts to Recreation Settings and Experiences

Alternative D would have similar impacts to recreation settings and experiences as Alternative C. However, because of the smaller total acreage of the proposed withdrawal under this alternative, the impacts to the recreation settings and experiences would be slightly increased, compared with Alternatives B and C.

Cumulative Impacts

The cumulative impacts assessment area identified for analysis of Alternative D's cumulative impacts to recreation resources is the same as described for Alternative A.

Based on the impacts described, Alternative D, if selected, is anticipated to result in an overall minor impact to visitor use, recreation opportunity, and recreation settings and experience. This is because the impacts from mining exploration and development that might occur under Alternative D would primarily be indirect and on a lesser scale than under Alternative A, and even considered cumulatively with the impacts of other past, present and reasonably foreseeable future actions, would not rise beyond a minor level.

4.16 SOCIAL CONDITIONS

4.16.1 Impact Assessment Methodology and Assumptions

The impacts analysis for social conditions evaluates how social condition effects of the project would be distributed among the communities and counties in the study area. Impacts to Coconino and Mohave counties in Arizona; Kane, San Juan, Washington, and Garfield counties in Utah; and minority and/or low-income communities will be considered for this analysis. Effects on groups and individuals outside the study area are addressed under stakeholder values.

Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate (Tables 4.16-1 and 4.16-2).

Table 4.16-1. Magnitude and Degrees of Effects on Social Conditions

Attribute of Effect	Description Relative to Social Conditions
Magnitude	
No Impact	Would not produce obvious changes in demographics; stakeholder values; public health and safety; or environmental justice populations.
Minor	Mining-related impacts on social conditions that would retain the existing character of the demographics; stakeholder values; public health and safety; or environmental justice populations but create a low level of change which would not alter the perception of the Grand Canyon region for stakeholders (either residents or visitors).
Moderate	Impacts on social conditions that would adversely affect stakeholders but can be mitigated.
Major	Mining-related impacts that would create a high degree of change within the existing population, permanently damage or drastically improve the perception and use of the area by stakeholders, cause harm to public health and safety or improve existing conditions, and adversely affect the environmental justice populations in the long term.

Table 4.16-2. Duration Definition of Effects on Social Conditions

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction)
Short-term	Less than 5 years
Long-term	Greater than 5 years

Impacts to social conditions from implementation of alternatives would be considered significant if one or more of the following occurs:

- Substantial gains or losses in population that would affect and possibly burden resources in the study area in the long term.
- Activities or operations that substantially alter stakeholder values, specifically quality of life. As discussed in Section 3.16, stakeholders can include locals and non-locals.
- Disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population that appreciably exceed those to the general population around the project area.

As described in Chapter 2, under Alternative A, there would be no reduction in the number of mining claims, or potential mining activity, therefore impacts described under Alternative A provide the baseline social impacts that are used to analyze the magnitude of change that could occur under the action alternatives (Alternative B, C, or D).

It is important to note that for the purpose of this analysis, only the White Mesa Mill is analyzed as a destination for ore mined from the proposed withdrawal parcels. It is the only active licensed mill operating in the U.S., and it has the capacity to process all ore mined from the proposed withdrawal parcels (see RFD in Appendix B). As other mills in the region are licensed, and become active, ore may be shipped to theses mills (i.e. the Shootaring Canyon Mill in Garfield County, Utah). However due to the uncertainty of the timing of these mills coming online and the specific company relationships or negotiations that may occur with mill operators to determine ore destination, these mills are not analyzed.

The projected effects of the alternatives on mining-related employment, discussed in Section 4.17, could lead to changes in study area population. The extent of population changes would depend on the degree to which new jobs directly and indirectly related to mining are filled by new migrants to the area (and their families) as opposed to being filled by existing residents. The significance of the population changes would also depend on where such changes occur.

There is considerable uncertainty regarding the locations of potential new mines, where new mining jobs would be based and where new migrants to the area would choose to locate their homes. Therefore, for purposes of assessing the potential magnitude of population changes associated with mining activity, the following simplifying assumptions were applied:

- 50% of new direct mining jobs were assumed to be filled by workers migrating to these communities;
- 25% of new indirect and induced jobs (see Section 4.17 for definitions) were assumed to be filled by new migrants to these communities – a smaller proportion because indirect and induced effects would be more widely dispersed across the North Study Area;
- Each new worker arriving in these communities was assumed to bring 1.24 dependents (based on the overall population to employment ratio for the study area); and
- New residents were assumed to be equally divided between Fredonia, Kanab and Colorado City.

It is important to note that direct employment would have a more localized effect to smaller communities like Fredonia, Colorado City, and Kanab, as opposed to indirect and induced employment, which would be spread out over the six-county study area. These assumptions were applied only for purposes of examining the potential magnitude of population changes associated with new mining-related employment under each of the alternatives. Actual effects could be larger or smaller than estimated in this analysis.

The analysis of stakeholder values is based on the assumption that alternatives seeking additional protection of the Grand Canyon watershed and limiting uranium mining activity would increase protection of the study area as a social amenity and component of area quality of life. Stakeholder values are difficult to quantify, particularly in the absence of data (i.e., interviews and studies that survey people's willingness to pay for some resource, protection, etc.). As discussed in Section 3.16.2, stakeholder values could be affected by changes in land management related to the proposed withdrawal areas; impacts could result if local or non-local individual's or community's values and beliefs are compromised, or if their values are not fulfilled. Further, as discussed in Section 3.16.1, stakeholder values are assessed using two basic perspectives—mineral activity support, or withdrawal support. Many different stakeholders have expressed an interest in the proposed mineral withdrawal because they support the withdrawal, they do not support the withdrawal, or they fall somewhere along a spectrum between the two attitudes. Accordingly, impacts to stakeholder values are assessed qualitatively.

Stakeholders include American Indian tribes, local governments, unincorporated area communities, mining companies, recreationists, and environmental and preservation groups, to name a few. It is important to note that stakeholders can include locals and non-locals, and/or individuals or groups inside and outside the study area. No specific survey of these groups was conducted for the analysis; thus, the discussion in the following section is based on comments received during scoping, comments on the Draft EIS, and input from tribal consultation and cooperating agencies.

The analysis of public health effects evaluates the potential for impacts from activity at the mines and from the transportation of uranium ore between mines and the White Mesa Uranium Mill in Blanding, Utah. The health effects analysis is based on a scale of risk.

The assessment of potential environmental justice impacts evaluates whether a disproportionate and adverse impact on a minority or low-income population would occur. As shown in Section 3.16, a total of ten geographies (five tribes, four communities, and one county) meet the criteria for identification as an "Environmental Justice community." These include all five tribes in the study area, including the Havasupai, Hopi, Navajo, Kaibab and Hualapai, the communities of Bitter Springs CDP and Kaibab CDP, Colorado City, Blanding, and San Juan County.

4.16.2 Incomplete or Unavailable Information

Distribution of Demographic Effects

Although specific mine locations are generally unknown, the locations of projected mining activity by withdrawal area, and the location of the existing mill in Blanding, make it possible to estimate the distribution of economic effects, and thus potential changes in population. It is not possible, however, to quantitatively estimate the further distribution of demographic changes to individual counties and municipalities within each of the two sub-areas (North Study Area, South Study Area), or to identify specific haul routes that would be used under different mining scenarios. A more detailed geographic distribution of effects would require specific information such as where future miners would choose to live and from which companies (in which locations) mining companies would purchase goods and services, all of which would be purely speculative at this point. However, qualitative judgments regarding the affected areas likely to be most affected are provided in the analysis methodology and assumptions.

Public Health and Safety

For the discussion of public health and safety (see Section 3.16.1), there is a lack of understanding as to the cause and effects of uranium exposure and cancer in humans. Therefore, as noted in Section 3.16.1, Subsection Public Health and Safety, much of the analysis in this document includes a discussion of the health impacts of depleted uranium (a by-product of uranium enrichment, not analyzed here) because of the paucity of studies of the effects of natural uranium on humans. This is not to imply that miners would be exposed to depleted uranium, but rather because more is known about the health effects from exposure to depleted uranium, it is used here to fill in the gaps of knowledge related to potential health impacts. Although the ore in the study area varies in concentration of 0.3% to 1.3% uranium, natural uranium would be more radioactive than depleted uranium and for a similar level of exposure, natural uranium would be expected to have more adverse health effects compared to the health effects information that has been gathered on depleted uranium.

Additionally, during public scoping, concerns regarding the potential health impacts from consumption of contaminated wildlife was brought up as a concern; however, there has not been a systematic study of the transfer of uranium from the plants and animals to humans through ingestion.

4.16.3 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

AREA COMMUNITIES

As discussed in Section 3.16, area communities and counties in the study area have different economic strategies which, at times, differ from federal land management policies. The counties and communities with specific economic development strategies encouraging diversity within the economy support a range of economic activities including commercial, industrial, and residential development, tourism, and natural resource exploration. For communities and counties, such as but not limited to Garfield County, where mining is an important aspect of maintaining economic diversity, Alternative A would result in a minor long-term beneficial impact as it would support economic development goals.

DEMOGRAPHICS

Estimated direct, indirect and induced employment (see Section 4.17) is used to estimate population changes from continued mining. As discussed above, this analysis assumes that 50% of new direct mining jobs and 25% of new indirect and induced employment would be filled by workers migrating to the study area. Additionally, each new worker arriving in study area would bring 1.24 dependents (based on the overall population to employment ratio for the study area); and new residents to the North Study Area (see Section 4.17) would be equally divided between Fredonia, Kanab and Colorado City.

Under Alternative A, total estimated annual employment for the North Study Area would be 513 jobs (235 direct, 119 indirect, and 159 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). Using the assumptions above, an estimated 190 workers and their families, totaling approximately 420 individuals, would relocate to the North Study area. This would result in a 0.08% increase in study area population over the 2010 data (see Table 3.16-1). Assuming these individuals would be equally divided between Fredonia and Colorado City, Arizona and Kanab, Utah, these communities could experience a one-time population increase of 140 individuals per community; this would be a 10.52%, 2.87%, and 3.21% increase, respectively, above 2010 data (see Table 3.16-1).

These potential increases in population are generally within the historic trends and future projections for population growth in these communities. Fredonia experienced a decline in population between 1990 and 2000, however population increased 26.8% between 2000 and 2010, with average annual growth estimated at 1.39% for this time period. Additionally, population is expected to increase another 1.6% in Fredonia over the next 20 years (see Table 3.16-1).

Colorado City has experienced continued population growth since 1990, increasing 37.4% between 1990 and 2000 and 44.6% between 2000 and 2010. Population is expected to continue to increase another 50% in Colorado City between 2010 and 2030.

In Kanab, Utah, population has also historically increased; between 1990 and 2000 population grew 8.4%, and between 2000 and 2010, Kanab experienced another 21% increase. As with Colorado City, population in Kanab is projected to continue growing between 2010 and 2030 (43%).

Under Alternative A, total estimated annual employment for the South Study Area would be 123 jobs (60 direct, 32 indirect, and 31 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). An estimated 45 workers and their families, totaling approximately 100 individuals, would relocate to the South Study Area. This would represent a 0.02% increase over 2010 study area population (see Table 3.16-1).

As with the North Study Area, the employment effects of uranium mining would likely not be equally distributed across the South Study Area. Tusayan is the only community located within (or in close proximity to) the proposed South Parcel, with Flagstaff and Williams located farther away. As discussed in Sections 3.17 and 4.17, it is not known whether Tusayan would serve as a base for mining activity in the proposed South Parcel, or if the base of mining activity in the South Study Area would be more widely distributed further from the proposed withdrawal area in larger communities such as Flagstaff and Williams. However, based on the relatively small employment effects in the South Study Area, and the likelihood that those effects would be distributed among larger communities such as Flagstaff and Williams, no discernible impact on demographics is expected in the South Study Area.

As demonstrated above, at study area level, potential changes in employment, and therefore population, are relatively small; population would increase by an estimated 521 individuals over the whole study area under Alternative A. Alternatively, if workers relocate to Fredonia or Colorado City, Arizona or Kanab, Utah, it could result in a larger increase (percent change) in population for these smaller communities. However, in consideration of historic trends and future population projections, Alternative A is not expected to increase the burden on area infrastructure beyond current conditions. Area communities have the infrastructure capacity to handle the potential increases in population. Current police, fire, medical, and educational facilities should be sufficient to handle direct employment and population changes.

Thus, communities to which workers relocate could experience minor, long-term, direct and indirect effects on the demographic composition of the region under Alternative A. Even though there is expected to be an increase in mining under Alternative A, impacts are not expected to result in wide-scale changes to community character, nor to alter the perception of the Grand Canyon region to either a resident or a visitor.

STAKEHOLDER VALUES

As stated in Section 3.16.1, there are two basic perspectives on mineral activity in the study area; people who embrace mining activity for the potential economic benefits and those who view uranium mining negatively and prefer to see study area lands closed to mining.

Mineral Activity Support

Residents of area communities and their governments benefit from the economic activity, such as employment, the multiplier effect of industry activity on other business sectors, and tax revenues, associated with mineral activity. The economic benefits of mineral activity (see Section 4.17) can influence local and state government support of this activity. Although not necessarily all residents of area communities or local governments support mineral activity, many do support the activity because of the economic benefits.

If local economic gains are realized as a result of continued mineral activity, Alternative A could result in direct and indirect impacts to local and state governments as potential economic gains (employment, compensation, etc.) could result in an increase in social well-being for affected business owners, employees, and their families, overall economic health of area communities, and overall increase in business activity. In Garfield, Kane, San Juan and Washington counties, mining employment is only 1.0% of area employment, and in Coconino and Mohave Counties, mining is only 0.6% of area employment (see Tables 3.17-4 and 3.17-7). Although mining sector jobs account for a small percentage of study area employment, mining jobs tend to be higher paying than tourism and other service-sector jobs.

Jobs with higher paying wages could result in increased well-being for individuals employed in mining jobs. These jobs also tend to contribute to social cohesion. Communities and residents can suffer from a lack of work, financial anxiety, ill-health, poor living conditions, etc. Employment, income (including income derived from tax revenues), education, and health are the foundations of a strong community, social cohesion, and well-being. In addition, economic development goals stated for many of the communities encourage a diversity of economic activity, thus, mineral activity would provide another employer contributing to the diversity of the local and regional economy.

Mineral activity scenarios under Alternative A represent an estimation of what mineral activity would be if no withdrawal occurs; thus Alternative A would result in the greatest amount of activity of all alternatives considered in this analysis and would therefore result in the greatest amount of economic gains for area residents, communities, and local and state governments that benefit from mineral activity and support continued mining.

As Alternative A would not result in mineral withdrawal, a minor long-term beneficial impact to individuals and groups who support mineral activity would result.

Withdrawal Support

As previously stated, individuals and groups who would prefer to see the proposed withdrawal lands removed from mineral entry feel that way because of a variety of factors, whether they treasure the solitude and isolation of area lands, have a cultural and spiritual connection to area lands, or benefit economically from tourist destinations in the study area. Residents of area communities and their governments benefit from the economic activity associated with tourism spending (see Sections 3.17 and 4.17 for a discussion of the economic impact of tourist activity). American Indian groups in particular have expressed deep concern about mineral activity near the Grand Canyon (Congressional Field Testimony 2007) based on prior tribal impacts and memories of those impacts from poor mining practices on their lands in the past. While Alternative A does not include any proposed mining on Navajo lands, it is important to note the Navajo Nation has indicated that they will not approve any uranium mining or processing within its boundaries (Shirley 2008).

Haul traffic on highways and state routes from proposed withdrawal parcels to the processing mill in Blanding, Utah, could also impact area quality of life for individuals and groups in the study area, particularly tourists who use these roads to access area destinations (see Transportation Conflicts discussion in Human Safety Risks, below).

Estimated mineral activity scenarios under Alternative A would result in the greatest amount of activity of all alternatives considered in this analysis. Thus, Alternative A would result in the most adverse direct and indirect impacts to individuals and groups who would like to see mineral activity prohibited in the project area. Stakeholder and quality of life values associated with withdrawal support (as described in Section 3.16) could be compromised because their values would not be fulfilled. Each person with some attachment to the proposed withdrawal area has a different reason for his or her opinions and feelings regarding area lands and mineral activity on these lands. However, in general, stakeholders who fall on the "withdrawal support" end of the spectrum would prefer to see less mineral activity.

Planning documents for area communities and counties also encourage increased tourism focused on the unique and scenic natural resources within the region (see Section 3.16). Though not specifically stated within planning documentation, should mineral activity directly impinge on tourism and recreation within an area community (as discussed in Section 4.17), Alternative A could be in partial conflict with these goals. As discussed in Section 4.17, the possibility of impacts on visitor use at the Grand Canyon due to uranium exploration and production cannot be dismissed.

Therefore, a moderate long-term adverse impact to individuals and groups who support mineral withdrawal would result.

PUBLIC HEALTH AND SAFETY

As described in Section 3.16, all proposed mine operations would be required to comply with stringent safety and health standards administered by MSHA through federal regulations at 30 CFR Parts 1 through 199 and, in particular, Part 57. MSHA regulations include requirements for ground support systems, mine ventilation, electrical systems, combustible fluid storage, underground shops, equipment specifications and maintenance, explosives storage and handling, dust control, monitoring and reporting requirements, alarm systems, worker personal safety equipment, and restrictions for public access.

To comply with MSHA standards, all proposed mining activity would require the necessary MSHA mine permit and an MSHA-approved miner training plan, escape and evacuation plan, and ventilation plan. Additionally, vents associated with breccia pipe mines are typically within the mine area proper, fenced from public access and far enough from the fence for radon to disperse to safe levels before reaching the fence. Since the EIS is not intended to analyze or authorize any particular mine but rather to estimate the effects of withdrawal from mining, impacts are based on typical mine design. When a new mine is proposed, a NEPA analysis will be conducted on the site specific design in a Mine Plan of Operations.

Health Safety Risks

As discussed in Section 3.16, public health aspects of uranium mining for this EIS are considered in terms of potential effects that would result at mines (from natural uranium ore); the potential health effects at the mills or other off-site processing centers (from concentrated [enriched, or yellowcake] or depleted uranium [which is a byproduct of enrichment, not mining]) are not considered here.

Cancer

As described in Section 3.16.1, although there is a chance of getting cancer from any radioactive material like uranium, scientists have not detected harmful radiation effects from low levels of natural uranium, although some may be possible (Craft et al. 2004). No human cancer has been documented as a result of exposure to natural or depleted uranium; thus, it is unlikely that exposure to uranium at the proposed withdrawal parcels and roads would cause harmful effects related to cancer (Lantz 2010).

Additionally, with appropriate mining practices, no carcinogens should be released during mining or if they are, they should be at levels below which no adverse health effects are seen. As to compounds that would be encountered during mining, the International Agency for Research on Cancer (IARC) has listed radon as a human carcinogen, however it has not classified imbedded depleted uranium DU and it has not classified uranium specifically as a carcinogen. Uranium does emit alpha particles and IARC classifies alpha particles as a known human carcinogen.

BEIR IV reported that eating food or drinking water that has normal amounts of uranium will most likely not cause cancer or other health problems in most people. BEIR IV used data from animal studies to estimate that a small number of people who steadily eat food or drink water that has larger-than-normal quantities of uranium in it could get a kind of bone cancer called a sarcoma. BEIR IV reported calculations that showed that if people steadily eat food or drink water containing about 1 pCi of uranium every day of their lives, bone cancer (sarcomas) would be expected to occur in about 1 to 2 of every million people after 70 years, based on the radiation dose alone. However, this is not certain because people normally ingest only slightly more than this amount each day, and people who have been exposed to larger amounts have not been found to develop cancer.

Two studies have examined the potential adverse health outcomes from living near uranium mine tailings and waste sites; one study examined the incidence of deaths due to cancers, comparing an exposed population to one that would not have been exposed to the mine tailings (Boice et al. 2003). There were no differences in cancer-related deaths between the populations living near the mine waste, compared with a control population. However, Au et al. (1998) found that individuals living near uranium mine waste did have defective repair of DNA damage, which suggests that they would be more susceptible to DNA trauma. The ability of uranium to cause DNA damage, increase in DNA mutations and transform cells into tumorigenic (tending to produce tumors) forms has been reported. These changes were seen at high uranium levels (at least 10 to 1,000 times above the EPA or National Institute for Occupational Safety and Health standards) (Stearns et al. 2005; Xie et al. 2010).

Ionizing Radiation

As previously stated, the risk of developing cancer is related to the dose of the radiation. Because depleted uranium is only weakly radioactive, an individual would have to inhale very large amounts of dust (on the order of grams) for the additional risk of lung cancer to be detectable in an exposed group.

Kidney Disease

Kidney disease is the most common adverse health effect from chemical exposure to uranium (see Section 3.16.1); however, it is important to note that studies of factors affecting the health of uranium miners and mill workers have not demonstrated unusual rates of kidney disease. A recent comparison of kidney tissue obtained from seven uranium workers and six referents with no known exposure to uranium showed that the groups were indistinguishable by pathologists experienced in uranium-induced kidney disease. It is interesting to note that that despite exposure to high levels of dusts of both soluble and insoluble uranium compounds, there were no measurable renal injuries among uranium miners and mill workers tested.

Lung Toxicity

As described in Section 3.16.1, respiratory diseases have been associated with human exposure to the atmosphere in uranium mines. Respiratory diseases in uranium miners (fatal in some cases) have been linked to exposure to silica dust, oxide dusts, diesel fumes, and radon[21] and its daughters, in conjunction with cigarette smoking. In several of these studies, the investigators concluded that, although uranium mining clearly elevates the risk for respiratory disease, uranium contributes minimally, if at all, to this risk. The mine air also contained radon and its daughters, and cigarette smoke, which are proven carcinogens. As in human studies, several animal studies in which uranium-containing dusts, such as carnotite uranium dust, were used reported the occurrence of respiratory diseases.

Studies among workers who had been exposed to uranium aerosols in strip and underground mines, mills, and processing facilities found more than the expected number of lung cancers only among underground miners and especially among miners who were cigarette smokers. No significant difference in the incidence rate of lung cancer was found between other workers who had been occupationally exposed to uranium and control populations. In addition to uranium dust, the mine air contained many other noxious aerosols (including silica, oxides of nickel, cobalt, and vanadium), radon and its daughters, diesel fumes, and cigarette smoke. Excess cancers were found among those underground miners whose radon daughter exposure exceeded 120 working level months. The rate of cancer incidence increased with increasing exposure to radon daughters.

No significant difference in cancer (of the lungs) was found between workers who are occupationally exposed to uranium and control populations. Other detailed studies conducted between 1950 and 1967 on the association between uranium mining and an increased incidence of cancer found lung cancer in the miners more than six times the rate expected. However, some of the miners were exposed to other potentially cancer-causing substances such as radon and its progeny, tobacco smoke, diesel smoke, and

[21] See a discussion in the following section about radon exposure.

solvents (carbon tetrachloride and trichloroethylene). These studies and a review of 11 uranium miner studies attributed the increased incidence of lung cancer to radon and its progeny and not to uranium. Thus, although uranium mining clearly elevates the risk for respiratory disease, uranium alone contributes minimally, if at all, to this risk (Craft et al. 2004).

Other Toxicities

Although very high doses of uranium (30 mg or higher) have caused reproductive problems, it is not believed that exposure to and the consumption of uranium related to this project would affect reproductive effects in workers and visitors to the proposed withdrawal areas (Craft et al. 2004).

Radon

As previously stated (see Section 3.16.1), radon is known to lead to an elevated risk of lung cancer in humans. Additionally, the IARC has listed radon as a human carcinogen. Risk for developing lung cancer associated with radon exposure varies, depending on how much radon is in the indoor environment, the amount of time spent in that indoor environment, and whether the person smokes or has ever smoked (Lantz 2010). The only way to know whether you are being exposed to elevated radon levels is to test the indoor environment (National Research Council's Commission on Life Sciences 1999). As previously stated, all mines would be required to comply with MSHA standards, including a ventilation plan and monitoring of radon levels.

Ingestion of Wildlife Exposed to Uranium

As discussed in Chapter 3.16, human health risks associated with the human consumption of wildlife exposed to uranium are not well understood. See previous discussions on human health risks associated with ingesting uranium for details on possible health risks.

Because Alternative A includes a continuation of current mineral activity, and the BLM or the Forest Service would continue to process mine development proposals, Alternative A includes the highest estimated mineral activity. Therefore, Alternative A could result in the most human health risks in terms of cancer, kidney disease, lung toxicity, other toxicities, and radon because there would be no reduction of activity. MSHA safety standards, which are required to be implemented at each mine, would minimize many of the above discussed risks by preventing workers from smoking in the mine, monitoring radon exposure, and requiring implementation of other required safety plans and measures. However, it is important to note that these risks are not expected to elevate above current conditions for mineral activity. Thus, impacts to Human Health are expected to be long term and minor.

Human Safety Risks

As previously noted in Section 3.16, potential safety risks associated with continuing mining operations could affect area recreationists and visitors; however, these risks would continue to be mitigated by safety mechanisms mandated by the land managing agencies such as the BLM and Forest Service, as well as MSHA. For instance, secured gates at mine operations are required. Thus, no impacts to human safety under Alternative A are expected.

Transportation Conflicts

Under Alternative A, there would be an estimated 317,505 haul trips over a 20-year period of heavy haul trucks carrying ore (see RFD, Appendix B), resulting in an annual average of 15,875 haul trips (estimated annual average of about 300 trips per week, or 50 trips per day for mines within the north, east and south parcels). This could impact roadways traveled by employees and visitors on routes in the study area, should accidents occur as a result of increased traffic. However, with implementation of speed restrictions by the mining company (e.g., maximum speeds of 25 mph on unpaved roads), the potential for impacts would be mitigated and minimized.

Daily haul trip estimates were calculated for each alternative, assuming that hauling activities would occur approximately 6 days/week, 52 weeks/year, over the course of 20 years. Daily haul trip estimates for each alternative were compared to 2009 AADT to determine the estimated change in traffic as a result of ore haul trucking operations.

Results of this comparison showed that, for Alternative A, the change in traffic would generally be less than a 1% change. The highest percent change was a 3.4% increase of traffic on portions of U.S. 191 and U.S. 89A that currently experience a low volume of traffic (1,000 AADT). The lowest change was a 0.01% increase for portions of U.S. 89, U.S. 160, U.S. 163, and I-40 that experience a higher volume of traffic (13,000 to 30,500 AADT).

Under Alternative A, given the estimated number of ore haul trips at 15,875 annually; indirect impacts on human safety may arise from the transport of ore materials from the proposed withdrawal parcels to the White Mesa Uranium Mill in Blanding, Utah, on roadways traveled by the public. In the event of an accident, there is a potential for hazardous contaminants to be released; however, exposure to uranium would be unlikely to affect the health of individuals within the vicinity. According to Denison, when accidents occur, drums transporting yellowcake are unlikely to be breached. If they are, the material usually stays inside the drums or remains within the damaged vehicle or in close proximity (Denison 2010a).

Between 1980 and 1991, uranium mines hauled more than 1,337,362 tons for 200 miles to the White Mesa Uranium Mill using a total of 16,048 truckloads (personal communication, M.M. Singh, June 29, 2010). During this time period, there was a total of five spills, or roughly one spill for every 3.2 million haul miles (personal communication, M.M. Singh, June 29, 2010). Data presented from 1980–1991 represent the most comprehensive information for haul trips to the mill; data for this period are especially relevant because it was a period of relatively high mining activity in the region. Since 1980–1991, conditions on these roadways have also changed. In addition, Hammond Trucking, an ore trucking company based out of Fredonia, Arizona, trucked ore out of the Arizona Strip from 1981 into the early 1990s. Hammond Trucking reports approximately 6 spills during the 10-year span in which trucks hauled upwards of one million tons of ore, resulting in an average of 0.6 spills per year (personal communication, G. Hammond, August 30, 2011).

For Alternative A, assuming all ore is transported to the White Mesa Mill in Blanding, Utah, it is anticipated that ore trucks will haul over an estimated 106,302,805 ton-miles annually. Frequency of accidents for ore haul trucking was based on USDOT statistical data for hazardous material transportation (USDOT 2007). USDOT (2007) estimates for accidents involving hazardous material transport on all roads and rural roads were 0.136 and 0.051 accidents per million ton-miles, respectively. The same statistics indicate that the frequency of rollovers and truck crashes during transportation of hazardous materials were 6.7×10^{-4} and 8.1×10^{-4} accidents per million ton-miles, respectively (USDOT 2007). Based on USDOT statistics, hazardous material transport accidents for Alternative A may occur about 1.43 times per year, or approximately 4 spills per million tons hauled, and a total of 28.6 hazardous material trucking accidents over 20 years.

For comparison, USDOT shows annual reported traffic accident rates in the U.S. to be approximately 1.8 accidents per 100 million miles traveled (2,979,321,000,000 miles/year with 5,505,000 reported accidents/year). In comparison, ore trucking accidents are estimated to occur at a frequency of less than 0.02 per million ton-mile; for Alternative A this would equate to an estimated 1.43 ore trucking accidents/year. Thus, the frequency of ore trucking accidents, when compared to reported accidents nationally, shows significantly less likelihood.

Impacts to Human Safety in terms of transportation conflicts under Alternative A are expected to be long term and moderate. Transportation containers and methods as well as area speed limits are expected to mitigate potential risks. Additionally, due to mitigation and other safety measures employed, ore trucking accidents are estimated to occur at a frequency less than general traffic accidents.

ENVIRONMENTAL JUSTICE

As discussed in Section 3.16.1, 10 geographies (five tribes, four communities, and one county) meet the criteria for identification as an “Environmental Justice community.” These include all five tribes in the study area (the Havasupai, Hopi, Navajo, Kaibab and Hualapai), the communities of Bitter Springs CDP, Kaibab CDP, Colorado City, Blanding, and San Juan County. The location of these communities in relation to the proposed withdrawal parcels can be seen on Figure 3.16-1. Physically, the Navajo Nation is adjacent to the eastern boundaries of the North and South withdrawal parcels, the Havasupai are adjacent to the western boundary of the South Parcel, and the Kaibab are adjacent to the northern boundary of the North Parcel. Thus, in terms of potential high and adverse impacts, these three tribes are the most likely to experience a disproportionate impact.

In particular, tribal environmental justice communities in the study area (Havasupai Indian Reservation, Hopi Tribe, and Navajo Nation, Kaibab Reservation [Kaibab Band of Paiutes], and Hualapai Tribe) have an intimate relationship with the landscape, especially that of the Grand Canyon area (see Section 3.12) and have expressed concerns about mineral activity in the region (see also Section 3.16).

As discussed throughout this EIS, Alternative A would not result in any major adverse impacts to the natural or physical environment; therefore this alternative is not expected to result in any disproportionately high and adverse environmental effects on minority and low-income populations.

However, as noted above under Public Health and Safety, Alternative A includes the highest estimated mineral activity as the proposed withdrawal would not be implemented. As a result, Alternative A would result in the most risk to human health in terms of cancer, kidney disease, lung toxicity, other toxicities, and radon. The higher risk of health impacts under Alternative A would disproportionately impact environmental justice communities. In particular, potential health impacts could be disproportionate for the three tribes (Navajo, Havasupai and Kaibab) physically adjacent to the three proposed withdrawal parcels, and areas which potential haul routes traverse, such as the Navajo Nation and San Juan County. These environmental justice populations could not relocate or otherwise avoid the increase health risks of Alternative A.

As a result, Alternative A could result in a minor, long-term impact to the 10 environmental justice geographies in terms of potential health risks.

Cumulative Impacts

The cumulative effects analysis area for Alternative A includes Coconino and Mohave counties in Arizona and Kane, San Juan, and Washington counties in Utah. All data on demographics, stakeholder values, public health and safety, and environmental justice apply to the cumulative effects analysis area analysis. The past and present land uses in the cumulative effects analysis area have had a direct effect on social conditions of the cumulative effects analysis area through changes to population (both types and amount). Past and present actions have resulted in the current social conditions in the cumulative effects analysis area, as described in Section 3.16.

Because of the presence of the Grand Canyon, the Kaibab National Forest, and the Arizona Strip, there are vast opportunities for recreation, solitude, and an overall perception of a higher quality of life. With projects that would enhance regional transportation systems and recreational areas such as the Four Forest

Restoration Initiative, Tusayan's and the North Kaibab Travel Management Projects, and the Greenway Trail and Parking Lot, there is the potential for more visitors to visit the region, which would increase employment opportunities and subsequently allow for slight increases in population.

From a lifestyle perspective, further development within the cumulative effects analysis area would change the landscape characteristics, existing conditions on area transportation systems, and existing landforms, which would contribute to an overall change in the sense of place for members of these counties. With the exception of the urban developed areas, the cumulative effects analysis area has a largely dispersed, rural, sparsely developed landscape.

As discussed above in Environmental Justice, Alternative A includes the highest estimated mineral activity and therefore could result in the most human health risks. In particular, because of the legacy of uranium mining on the Navajo Nation and their past experiences with health problems from working in the mines as discussed in Stakeholder Values in 3.16, Alternative A could lead to long-term, minor, cumulative adverse impacts and cumulatively higher health risks.

4.16.4 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

AREA COMMUNITIES

As discussed in Section 3.16, and under Alternative A, area communities and counties in the study area have different economic strategies, which can differ from federal land management policies. For communities and counties, such as but not limited to Garfield County, where mineral activity is an important aspect of maintaining economic diversity, Alternative B would result in a minor long-term adverse impact as it could potentially be in conflict with study area economic development goals that would otherwise be supported by Alternative A.

DEMOGRAPHICS

Under Alternative B, total estimated annual employment for the North Study Area would be 159 jobs (73 direct, 37 indirect, and 49 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). Using the assumptions presented previously, an estimated 60 workers and their families, totaling approximately 130 individuals, would relocate to the North Study area. The number of individuals that could potentially relocate to the North Study Area (n = 130) would be approximately 70% less than expected for Alternative A (n=420). As with Alternative A, if these individuals are evenly distributed amongst Fredonia and Colorado City, Arizona and Kanab, Utah, each city would see approximately 45 individuals relocate to these communities.

Under Alternative B, total estimated annual employment for the South Study Area would be 12 jobs (6 direct, 3 indirect, and 3 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). An estimated 10 individuals would relocate to the South Study Area; this would be an approximately 90% decrease from individuals expected to relocate under Alternative A (n = 100).

Estimated population changes for Alternative B would be much less than estimated for Alternative A. As many as 520 individuals could relocate to the study area under Alternative A, compared to an estimated 140 individuals who could relocate to the study area under Alternative B; this is a 73% difference between alternatives A and B. In the context of study area population, this would not result in obvious changes in demographics across the six counties (approximately 500,000 individuals in 2010 [see Table 3.16-1]). For the communities of Fredonia, Kanab, and Colorado City with a combined population of approximately 10,000 individuals in 2010 (see Table 3.16-1), the “loss” of 380 individuals could result in minor changes in population, however the overall character of area demographics would not change.

As discussed in Section 3.17, property, income, and sales-related taxes are important sources of revenue for cities and counties. These revenues are used to fund government services, such as police, fire protection, schools, roads, etc. When there are decreases in employment and income, less property, income and sales taxes are generated and collected by states, counties, cities and towns. Alternative B is projected to result in less tax revenue than Alternative A (see Section 4.17). However, because some additional uranium mining activity is expected under Alternative B, revenues are still expected to be greater than under existing conditions. The smaller increases in employment anticipated under Alternative B would also likely require less expansion of government activities (and costs) to serve new residents. Thus, implementation of Alternative B is not expected to reduce the ability of municipalities, counties, and states to provide needed services and infrastructure.

Therefore, Alternative B could result in minor direct and indirect impacts to demographics.

STAKEHOLDER VALUES

Impacts discussed under Alternative A would be similar under all action alternatives, including Alternative B; the difference between types of impacts is a matter of degree. Alternative B includes some mineral activity (primarily in the North Parcel) but less estimated activity than under Alternative A. Because mineral activity would still occur to some degree, the same groups and individuals who support mineral activity or support mineral withdrawal are likely to be affected. However, individuals and groups who support mineral activity would be more adversely directly and indirectly impacted by Alternative B because it includes the least estimated mineral activity, while individuals and groups who support mineral withdrawal would also be more (beneficially) impacted for the same reason. Thus, Alternative B would result in a moderate long-term impact to stakeholder values.

PUBLIC HEALTH AND SAFETY

Health Risks

As with stakeholder values, impacts to public health and safety, specifically health risks (cancer, kidney disease, lung toxicity, other toxicities, and radon), would be similar under all action alternatives, including Alternative B; the difference between types of impacts is a matter of degree. The least mineral activity is estimated under Alternative B; therefore, the least risk of human health impacts is anticipated. Based on the attributes of effect described at the beginning of Section 4.16, no impact to health is anticipated.

Human Safety Risks

Under Alternative B, direct impacts to public health and safety would be similar to Alternative A; however, there would be fewer impacts. There would be fewer heavy-haul trips, which would average approximately 5,311 trips annually, 67% less than Alternative A. This reduction would minimize the potential for impacts on traffic safety in the proposed withdrawal parcels.

Under Alternative B, indirect impacts to public health and safety would be similar to Alternative A. However, with the reduction of heavy-haul trips, there is less potential for impact on traffic safety for drivers traveling on the same roads from the proposed withdrawal parcels to Blanding, Utah, than Alternative A.

For Alternative B, it is estimated that ore trucks will traverse over 36,219,005 ton-miles annually. As further described for Alternative A (see Transportation Conflicts in Section 4.16.3), USDOT (2007) estimates for accidents involving hazardous material transport on all roads and rural roads were 0.136 and 0.051 accidents per million ton-miles, respectively. The same statistics indicate that the frequency of rollovers and truck crashes during transportation of hazardous materials were 6.7×10^{-4} and 8.1×10^{-4} accidents per million ton-miles, respectively (USDOT 2007). For Alternative B, this would equate to 0.49 accidents per year, compared to 1.43 times per year for Alternative A. Potential truck hauling accident results show that estimated accidents for Alternative B are comparatively less than Alternative A in which ore trucking traverses proportionately more ton-miles per year. Additionally, the frequency of ore trucking accidents, when compared to reported traffic accidents nationally, shows significantly less likelihood than Alternative A. Thus, impacts to Human Safety in terms of transportation conflicts under Alternative B are expected to be long term and minor.

ENVIRONMENTAL JUSTICE

The environmental justice study area for Alternative B does not change from that identified for Alternative A. Therefore, the same communities discussed under Alternative A are also considered for all action alternatives, including Alternative B.

Potential health risks associated with mineral activity as described above under Public Health and Safety would pose much less of a risk to the ten environmental justice communities than Alternative A. However, because there is still a potential health risk, although the potential risk and associated impacts would be much less than any other alternative, there could be a disproportionate impact the environmental justice communities. These impacts could result from physical proximity to the mines, and from exposure via haul trucks on area roads.

Because proposed mining activity under Alternative B is the lowest, and thus the potential risk and associated impacts would be much less than any other alternative, impacts would not result in obvious changes to these 10 communities. As noted above for Health Risks, and based on the attributes of effect described at the beginning of Section 4.16, no impact to health is anticipated; thus, no direct or indirect impacts to environmental justice communities are expected under Alternative B.

Cumulative Impacts

Cumulative impacts under Alternative B would be similar in magnitude to Alternative A, although there would be fewer employment opportunities and subsequently less revenue that would be generated as a result of the reduced number of mines available for development and production. This could impact the perceived quality of life, depending on the perspective one has of the Grand Canyon region. For this analysis, although there is a measurable difference in anticipated mineral exploration and development under the RFD scenarios (see Appendix B), cumulative impacts would not be substantially different to warrant a separate discussion here for Alternative B.

4.16.5 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Direct and Indirect Impacts

AREA COMMUNITIES

As discussed in Section 3.16, and under Alternative A, area communities and counties in the study area have different economic strategies, which can differ from federal land management policies. For communities and counties, such as but not limited to Garfield County, where mineral activity is an important aspect of maintaining economic diversity, Alternative C would result in a minor long-term adverse impact as it could potentially be in conflict with study area economic development goals that would otherwise be supported by Alternative A.

DEMOGRAPHICS

Under Alternative C, total estimated annual employment for the North Study Area would be 277 jobs (127 direct, 64 indirect, and 86 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). Using the assumptions presented previously, an estimated 100 workers and their families, totaling approximately 225 individuals, would relocate to the North Study area. The number of individuals that could potentially relocate to the North Study Area (n = 225) would be approximately 45% less than expected for Alternative A (n=420). As with Alternative A, if these individuals are evenly distributed among Fredonia and Colorado City, Arizona and Kanab, Utah, each city would see approximately 75 individuals relocate to these communities.

Under Alternative C, total estimated annual employment for the South Study Area would be 66 jobs (32 direct, 17 indirect, and 17 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). An estimated 55 individuals would relocate to the South Study Area; this would be an approximately 45% decrease from individuals expected to relocate under Alternative A (n = 100).

Estimated population changes for Alternative C would be less than estimated for Alternative A. As many as 520 individuals could relocate to the study area under Alternative A, compared to an estimated 280 individuals who could relocate to the study area under Alternative C; this is a 46% difference between alternatives A and C. In the context of study area population, this would not result in obvious changes in demographics across the six counties (approximately 500,000 individuals in 2010 [see Table 3.16-1]). For the communities of Fredonia, Kanab, and Colorado City with a combined population of approximately 10,000 individuals in 2010 (see Table 3.16-1), the "loss" of 240 individuals could result in minor changes in population, however the overall character of area demographics would not change.

Like Alternative B, Alternative C is projected to result in less tax revenue than Alternative A (see Section 4.17). However, because some additional uranium mining activity is expected under Alternative C, revenues are still expected to be greater than under existing conditions. The smaller increases in employment anticipated under Alternative C would also likely require less expansion of government activities (and costs) to serve new residents. Thus, implementation of Alternative C is not expected to reduce the ability of municipalities, counties, and states to provide needed services and infrastructure.

Therefore, Alternative C could result in minor direct and indirect impacts to demographics.

Stakeholder Values

Impacts discussed under Alternative B would be similar to this discussion of Alternative C. Alternative C includes some mineral activity (concentrated in the North Parcel) but less estimated activity than Alternative A. Because mineral activity would still occur to some degree, the same groups and individuals who support mineral activity or support mineral withdrawal are likely to be affected. However, individuals and groups who support mineral activity would be more directly and indirectly adversely impacted, while individuals and groups who support mineral withdrawal would also be more (beneficially) impacted.

Thus, Alternative C would result in a moderate long-term impact to stakeholder values.

PUBLIC HEALTH AND SAFETY

Health Risks

Impacts discussed under Alternative B would be similar to this discussion of Alternative C. Less mineral activity is estimated under Alternative C than under Alternative A; therefore, less risk of human health impacts is anticipated. Based on the attributes of effect described at the beginning of Section 4.16, no impact to health and safety is anticipated.

Human Safety Risks

Under Alternative C, direct impacts to public safety would be similar to Alternative A. However, annual heavy-haul trips would be reduced by 42% compared to Alternative A, and the potential for impact on traffic safety within the proposed withdrawal areas would be lower than for Alternative A. This reduction would minimize the potential for impacts on traffic safety in the proposed withdrawal parcels.

For Alternative C, it is estimated that ore trucks will traverse approximately 61,739,405 ton-miles annually. As further described for Alternative A (see Transportation Conflicts in Section 4.16.3), U.S. DOT (2007) estimates for accidents involving hazardous material transport on all roads and rural roads were 0.136 and 0.051 accidents per million ton-miles, respectively. The same statistics indicate that the frequency of rollovers and truck crashes during transportation of hazardous materials were 6.7x10-4 and 8.1x10-4 accidents per million ton-miles, respectively (U.S. DOT 2007). For Alternative C, this would equate to 0.83 accidents per year, compared to 1.43 times per year for Alternative A. Potential truck hauling accidents results show that estimated accidents for Alternative C are comparatively less than Alternative A in which ore trucking traverses proportionately more ton-miles per year. Additionally, the frequency of ore trucking accidents, when compared to reported traffic accidents nationally, shows significantly less likelihood.

Under Alternative C, indirect impacts to public safety would be similar to, but less than, Alternative A. With the reduction of heavy haul trips, there is less potential for impact on traffic safety for drivers traveling on the same roads from the proposed withdrawal parcels to Blanding, Utah, than Alternative A. Thus, impacts to human safety in terms of transportation conflicts under Alternative C are expected to be long term and minor.

ENVIRONMENTAL JUSTICE

Direct and indirect impacts to environmental justice are very similar between Alternatives B and C. Potential health risks associated with mineral activity as described above under Public Health and Safety would pose less of a risk to the 10 environmental justice communities than those discussed under Alternative A. However, although there are some health risks associated with mineral activity in general, and based on the attributes of effect described at the beginning of Section 4.16, and Health Risks discussion above, no impact to health is anticipated; thus no direct or indirect impacts to environmental justice communities are expected under Alternative C.

Cumulative Impacts

Cumulative impacts under Alternative C would be similar in magnitude to Alternative A. For this analysis, there is not enough of a measurable difference in anticipated mineral exploration and development under the RFD scenarios (see Appendix B) to indicate that cumulative impacts would be substantially different to warrant a separate discussion for Alternative C.

4.16.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

AREA COMMUNITIES

As discussed in Section 3.16, and under Alternative A, area communities and counties in the study area have different economic strategies, which can differ from federal land management policies. For communities and counties, such as but not limited to Garfield County, where mineral activity is an important aspect of maintaining economic diversity, Alternative D would result in a minor long-term adverse impact as it could potentially be in conflict with study area economic development goals that would otherwise be supported by Alternative A. However, of the action alternatives, Alternative D would result in the least adverse impacts because the alternative includes a similar level of mineral activity as estimated for Alternative A.

DEMOGRAPHICS

Under Alternative D, total estimated annual employment for the North Study Area would be 448 jobs (205 direct, 104 indirect, and 139 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). Using the assumptions presented previously, an estimated 165 workers and their families, totaling approximately 365 individuals, would relocate to the North Study area. The number of individuals that could potentially relocate to the North Study Area (n = 365) would be approximately 12.7% less than expected for Alternative A (n=420). As with Alternative A, if these individuals are evenly distributed amongst Fredonia and Colorado City, Arizona and Kanab, Utah, each city would see approximately 120 individuals relocate to these communities.

Under Alternative D, total estimated annual employment for the South Study Area would be 85 jobs (41 direct, 22 indirect, and 22 induced [see Section 4.17, Projected Average Annual Economic Effects, by alternative]). An estimated 70 individuals would relocate to the South Study Area; this would be an approximately 30% decrease from individuals expected to relocate under Alternative A (n = 100).

Estimated population changes for Alternative D would be less than estimated for Alternative A, although there would be less change between Alternatives A and D, than other action alternatives. As many as 520 individuals could relocate to the study area under Alternative A, compared to an estimated 435 individuals who could relocate to the study area under Alternative D; this is a 16% difference between alternatives A and D. In the context of study area population, this would not result in obvious changes in demographics across the six counties (approximately 500,000 individuals in 2010 [see Table 3.16-1]). For the communities of Fredonia, Kanab, and Colorado City with a combined population of approximately

10,000 individuals in 2010 (see Table 3.16-1), the "loss" of 85 individuals could result in a change in population, however this change would not be perceptible.

Like Alternatives B and C, Alternative D is projected to result in less tax revenue than Alternative A (see Section 4.17). However, because some additional uranium mining activity is expected under Alternative D, revenues are still expected to be greater than under existing conditions. The smaller increases in employment anticipated under Alternative D would also likely require less expansion of government activities (and costs) to serve new residents. Thus, implementation of Alternative D is not expected to reduce the ability of municipalities, counties, and states to provide needed services and infrastructure.

Thus, no direct or indirect impacts to demographics are anticipated under Alternative D.

STAKEHOLDER VALUES

Impacts discussed under Alternatives B and C would be similar to this discussion of Alternative D. Alternative D includes some mineral activity (concentrated in the North Parcel) but less estimated activity than under Alternative A. Because mineral activity would still occur to some degree, the same groups and individuals who support mineral activity or support mineral withdrawal are likely to be affected. However, individuals and groups who support mineral activity would be more directly and indirectly adversely impacted, while individuals and groups who support mineral withdrawal would also be more (beneficially) impacted.

Thus, Alternative D would result in a moderate long-term impact to stakeholder values.

PUBLIC HEALTH AND SAFETY

Health Risks

Impacts discussed under Alternative A would be similar to this discussion of Alternative D. Less mineral activity than Alternative A is estimated under Alternative D; however, the amount of activity estimated for Alternative D is not substantially different. For instance, approximately 30 mines are estimated for Alternative A, while 26 mines are estimated for Alternative D (see RFD, Appendix B). Alternative D does have less human health risks than Alternative A. Based on the attributes of effect described at the beginning of Section 4.16, and because impacts are expected to be relatively similar to Alternative A, impacts to Human Health under Alternative D are expected to be long-term and minor.

Human Safety Risks

Under Alternative D, direct impacts to public safety would be similar to Alternative A. However, annual heavy-haul trips would be reduced by 14%, and the potential for impact on traffic safety within the proposed withdrawal parcels would be lower than under Alternative A. This reduction would minimize the potential for impacts on traffic safety in the proposed withdrawal parcels.

For Alternative D, it is estimated that ore trucks will traverse approximately 91,958,005 ton-miles annually. As further described for Alternative A (see Transportation Conflicts in Section 4.16.3), USDOT (2007) estimates for accidents involving hazardous material transport on all roads and rural roads were 0.136 and 0.051 accidents per million ton-miles, respectively. The same statistics indicate that the frequency of rollovers and truck crashes during transportation of hazardous materials were 6.7×10^{-4} and 8.1×10^{-4} accidents per million ton-miles, respectively (USDOT 2007). For Alternative D, this would equate to 1.24 accidents per year, compared to 1.43 accidents per year for Alternative A. Potential truck hauling accidents results show that estimated accidents for Alternative D are slightly less than Alternative

A. Additionally, the frequency of ore trucking accidents, when compared to reported traffic accidents nationally, shows significantly less likelihood.

Under Alternative D, indirect impacts to public safety would be similar to Alternative A. With the reduction of heavy-haul trips, there is less potential for impact on traffic safety for drivers traveling on the same roads from the proposed withdrawal parcels to Blanding, Utah, than Alternative A; however, the level of traffic and associated risk of accidents are relatively similar. Thus, impacts to human safety in terms of transportation conflicts under Alternative D are expected to be long term and moderate.

ENVIRONMENTAL JUSTICE

Under Alternative D, direct and indirect impacts to environmental justice would be similar to those described under Alternative A. Although the No Action Alternative (Alternative A) includes the highest estimated mineral activity, the number of mines estimated for Alternative D (n = 26) is only slightly lower than Alternative A (n = 30). As a result, Alternative D would result in a similar level of risk as Alternative A to human health in terms of cancer, kidney disease, lung toxicity, other toxicities, and radon. The risk of health impacts under Alternative D would disproportionately impact environmental justice communities, particularly the three tribes (Navajo, Havasupai and Kaibab) physically adjacent to the three proposed withdrawal parcels, and areas which potential haul routes traverse, such as the Navajo Nation and San Juan County. These environmental justice populations could not relocate or otherwise avoid the health risks of Alternative D.

As a result, Alternative D could result in a minor, long-term impact to the ten environmental justice geographies in terms of potential health risk.

Cumulative Impacts

Cumulative impacts under Alternative D would be similar in magnitude to Alternative A. As with Alternative A, because of the legacy of uranium mining on the Navajo Nation and their past experiences with health problems from working in the mines as discussed in Stakeholder Values in Section 3.16, Alternative D could lead to long-term, minor, cumulative adverse impacts and cumulatively higher health risks. For this analysis, there is not enough of a measurable difference in anticipated mineral exploration and development under the RFD scenarios to indicate that cumulative impacts would be substantially different to warrant a separate discussion for Alternative D.

4.17 ECONOMIC CONDITIONS

This section describes the potential effects of the alternatives on economic conditions in the study area. The study area for economic conditions is the same as the study area described for social conditions (see Section 3.16), and includes Coconino County and Mohave County in Arizona and Garfield County, Kane County, San Juan County, and Washington County in Utah.

The Grand Canyon is a substantial natural barrier that effectively divides the study area into two separate geographic and economic sub-areas. In order to effectively capture this distinction, the economic analysis describes economic conditions and the potential effects of the alternatives by sub area: the area north of the Grand Canyon (North Study Area) and the area south of the Grand Canyon (South Study Area). All of the Utah counties (Garfield, Kane, San Juan and Washington) are located in the North Study Area, along with small portions of Coconino and Mohave Counties of Arizona. The majority of the land area and population of Coconino and Mohave Counties resides in the South Study Area.

4.17.1 Impact Assessment Methodology and Assumptions

Each of the alternatives may affect the amount of uranium exploration and development that occurs within the proposed withdrawal areas over the duration of the proposed withdrawal. The assumptions regarding the amount of uranium mining activity that would occur under each alternative, including total production and the number of mines that would be developed, were developed for the Reasonably Foreseeable Development Scenarios and are described in Appendix B.

Assumptions for this analysis include the following:

- The total proposed withdrawal would last for 20 years.
- Given limits in industrial capacity, a maximum of six mines for all three parcels with a 7-year life cycle per mine (including planning and permitting, mine development, mine production and reclamation) could be in production at any given time.
- All uranium from the mines would be extracted.
- No mines would be operating under interim management.
- The price of uranium would be stable at $40 per pound in 2010 dollars. This reflects the value of the resource after milling. (Sensitivity of the economic analysis to this assumption is discussed later in this section.)
- All ore produced from the proposed withdrawal areas would be milled in the North Study Area. Fifteen percent of the value of the uranium mined from the proposed withdrawal areas ($6 per pound of the $40 per pound total) would be added through the milling process (Tetra Tech 2009).
- The relationships between the value of uranium production, direct employment in uranium mining, indirect and induced economic activity, and government revenues can be reasonably approximated using the IMPLAN economic modeling system (with appropriate adjustments, as described later).
- The economic relationships within the IMPLAN model for 2009 (e.g., industry production functions, worker productivity and compensation and the share of revenues accruing to federal, state and local governments) will remain a reasonable approximation of those relationships in the future.
- Severance tax revenues collected by the State of Arizona were estimated independently of the IMPLAN model. Arizona levies a 2.5% severance tax on 50% of the value of uranium production, net of deductible production costs (such as the costs of equipment). For this analysis, 50% of the estimated direct value-added of uranium mining (excluding milling) was assumed to provide a reasonable estimate of the net taxable value for purposes of projecting severance tax revenues.

For ease of comparison with the description of current economic conditions provided in Chapter 3, economic effects in this section are generally presented in terms of projected average annual economic effects over the proposed 20 year withdrawal period.

Economic effects under each of the withdrawal alternatives (Alternatives B, C, and D) are compared to Alternative A. Effects of Alternative A are compared to current economic conditions, as described in Chapter 3. The effects analysis for Alternative A is presented first and contains the most detailed narrative regarding how the effects were evaluated. The effects analysis narrative for the remaining alternatives is somewhat briefer and does not repeat background information that is consistent across all of the alternatives.

Substantive Changes from the DEIS

Both the description of the affected environment for economics and the economic effects analysis in the DEIS (Section 3.16 and Section 4.16 of that document) were the subject of many substantive comments (provided in Section 5 of the FEIS). While some of these comments focused on relatively minor issues in terms of presentation or interpretation, other comments (both from parties favoring the withdrawal of at least some BLM lands from future mining claims and parties opposed to any withdrawal) focused on more fundamental flaws in the DEIS economic analysis – particularly in relation to the analysis of the economic and fiscal benefits of mining activity under each alternative.

In light of this situation, BLM and SWCA Environmental Consultants retained additional socioeconomic expertise to review the comments and the DEIS economic analysis. That review determined that there were fundamental flaws in the DEIS economic analysis that needed to be addressed. In particular, the DEIS incorrectly calculated the number of direct mining jobs under each alternative, and then used that incorrect calculation to estimate indirect and induced effects on total jobs. Impacts on output, value-added and fiscal conditions were estimated separately, but other errors in these calculations led to results that were not consistent with the Reasonably Foreseeable Development Scenarios described in Appendix B.

Given the extent of these issues, a new economic impact analysis was conducted for the FEIS. The process for conducting this analysis is described in this section. The revised methodology produces economic impact estimates that are simultaneously consistent with both the assumptions made in the RFD concerning total uranium production under each alternative and its value and the assumptions provided by industry concerning the number of jobs needed per mine, by phase of mining activity.

Given the issues with the DEIS analysis, the largest differences in the analysis of the economic benefits of mining are in terms of direct and total mining-related jobs—where the FEIS estimates are considerably higher (536 total annual jobs for Alternative A versus 332 in the DEIS). The differences in the other metrics (e.g. output and fiscal impacts) are much smaller.

Both the DEIS and the FEIS applied consistent methods in estimating the economic impacts of mining for each alternative. Consequently, the relative economic impacts of the alternatives (e.g., the ratios of estimated economic activity between the various alternatives) are similar in both analyses.

Another important change to the economic effects analysis in the FEIS is the more explicit recognition of the areas where there is incomplete or unavailable information concerning potential economic effects, as described later in this section.

Economic Impact Modeling

The economic impacts of differing levels of uranium production under the alternatives were estimated using IMPLAN v3.0. IMPLAN is an input/output (I/O) modeling system originally developed for the U.S. Forest Service and is widely used by both private sector and public sector economists for impact analyses throughout the United States. The impact analysis made use of the most recent available IMPLAN data for 2009.

An input-output analysis estimates the overall economic impact on all industrial sectors that results from direct economic activity in one or more specific sectors. The overall economic impact can be broken down into three categories.

- Direct: the initial economic effects from uranium production. These effects would include the output and jobs associated with the mines and the mill.

- Indirect: the economic effects resulting from purchases of goods and services by directly affected industries from other firms. Revenues and jobs associated with hauling ore from the mines to Blanding would be an example of an indirect effect.
- Induced: the economic effects stimulated by purchases by employees of directly and indirectly affected businesses. Purchases of groceries and home rental expenditures by uranium miners would be an example of an induced effect.

These definitions differ somewhat from the use of the terms direct and indirect in the context of NEPA (as used throughout this EIS). In particular, both indirect and induced economic effects are considered indirect effects in the context of NEPA.

Separate IMPLAN models were created for the area north of the Grand Canyon and the area south of the Grand Canyon. The North Study Area contains the Utah counties of Washington, Kane, Garfield and San Juan as well as the following zip codes from Coconino and Mohave Counties in Arizona: 86021, 86022, 86036, 86052, and 86432. The South Study Area contains all other zip codes in Coconino and Mohave counties.

IMPLAN models are highly detailed representations of local economies, containing up to 440 separate sectors (industries). There is not, however, a sector in IMPLAN that specifically and uniquely represents uranium mining. Instead, uranium mining and milling activities are both contained in IMPLAN sector 24—mining gold, silver, and other metal ore.

The IMPLAN model, however, is flexible enough to allow industry production functions to be modified to more closely reflect local circumstances. Industry sources provided estimates of the direct employment associated with each phase of the mining process (personal communication, C. Woodward, Denison 2010). The phases of the project, durations, and number of employees during each phase were defined as follows:

- Planning and Permitting: 2 years, 20 employees per year
- Mine Development: 1 year, 35 employees
- Mine Production: 3 years, 35 employees per year
- Reclamation: 1 year, 20 employees per year

Figure B-5 of the RFD (see Appendix B) provided a matrix displaying the projected mines, by phase of mining activity, anticipated under Alternative A (No Withdrawal). To estimate the direct employment anticipated to occur under that alternative, the study team created a modified version of Figure B-5 using the annual mine employment by phase estimates described above. As shown in Figure 4.17-1, the combination of the projected mining activity described in the RFD with the industry employment by phase estimates produces an estimated annual average of 293 direct mining jobs over the 20 study period under Alternative A.

The RFD projects that a total of 79 million pounds of uranium would be produced under Alternative A, or an average of about 3.97 million pounds per year over the 20 year period. Based on the RFD assumed price of $40 per pound, this reflects an average annual value of production of about $158 million (in 2010 dollars).

Under the default production function for IMPLAN sector 24 (Mining gold, silver and other metal ore) $158 million in annual uranium production would produce an estimated 263 direct mining jobs. Although this result is of the same basic magnitude as the industry-based estimate of 293 direct mining jobs shown in Figure 4.17-1, the study team used the industry information to modify the IMPLAN production function to more closely reflect projected employment ratios specific to uranium mining by increasing the employment to output ratio (reducing labor productivity). This adjustment has the effect of producing

Alternative A: Direct Employment per Industry Estimates of Jobs by Mining Phase

	AZ-1	Pinenut	Kanab North	Canyon	New Mine 1	New Mine 2	New Mine 3	New Mine 4	New Mine 5	New Mine 6	New Mine 7	New Mine 8	New Mine 9	New Mine 10	New Mine 11	New Mine 12	New Mine 13	New Mine 14	New Mine 15	New Mine 16	New Mine 17	New Mine 18	New Mine 19	New Mine 20	New Mine 21	New Mine 22	New Mine 23	New Mine 24	New Mine 25	New Mine 26	Total Employment
Year 1	35	20	20	20	20	20	20																								**155**
Year 2	20	20	20	20	20	20	20																								**140**
Year 3		35	35	35	35	35	35																								**210**
Year 4		35	35	35	35	35	35	20	20	20	20	20	20																		**330**
Year 5		35	35	35	35	35	35	20	20	20	20	20	20																		**330**
Year 6		35	35	35	35	35	35	35	35	35	35	35	35																		**420**
Year 7		20	20	20	20	20	20	35	35	35	35	35	35	20	20	20	20	20	20												**450**
Year 8								35	35	35	35	35	35	20	20	20	20	20	20												**330**
Year 9								35	35	35	35	35	35	35	35	35	35	35	35												**420**
Year 10								20	20	20	20	20	20	35	35	35	35	35	35	20	20	20	20	20	20						**450**
Year 11														35	35	35	35	35	35	20	20	20	20	20	20						**330**
Year 12														35	35	35	35	35	35	35	35	35	35	35	35						**420**
Year 13														20	20	20	20	20	20	35	35	35	35	35	35	20	20	20	20	20	**430**
Year 14																				35	35	35	35	35	35	20	20	20	20	20	**310**
Year 15																				35	35	35	35	35	35	35	35	35	35	35	**385**
Year 16																				20	20	20	20	20	20	35	35	35	35	35	**295**
Year 17																										35	35	35	35	35	**175**
Year 18																										35	35	35	35	35	**175**
Year 19																										20	20	20	20	20	**100**
Year 20																															**0**
Averages	**28**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**29**	**293**

Source: BBC Research and Consulting based on Figure B-5 from Appendix B (RFD) and mine phase employment estimates provided by industry (personal communication, C. Woodward, Denison 2010).

Notes:

Assumes 30 mines total, with no more than 6 in production at one time

Assumes the following regarding each phase:

- Initial permitting and planning: 2 years, 20 employees
- Development of mine: 1 year, 35 employees
- Production: 3 years, 35 employees
- Reclamation: 1 year, 20 employees

Figure 4.17-1. Projected direct mining employment under Alternative A.

larger direct employment estimates based on projected uranium production under each alternative, but also reduces the indirect employment effects (if the industry spends a larger proportion of revenues on labor costs, there are fewer dollars spent on purchases from other industries).

After modifying the industry production function, each alternative was modeled for each study area based on its average annual projected value of uranium production. This required several additional assumptions:

- The annual uranium production values reflect the value of processed uranium, not ore, and thus include value-added in the milling process. Based on industry data (Tetra Tech 2009), 15% of the total production value from both study areas was assumed to occur at the mill—and was consequently allocated to the North Study Area.
- The remaining 85% of the projected annual production value for each scenario was allocated between the study areas based on the projected average annual output of the mines in each proposed withdrawal parcel. Production from the North and East parcels was allocated to the North Study Area, while production from the South Parcel was allocated to the South Study Area.

It should be noted that the resulting total economic effects under each alternative include the value-added in the milling and hauling processes, as well as indirect effects on other businesses that support the uranium industry and induced effects on businesses that would provide goods and services to employees (direct and indirect) and their households.

Other Economic Effects Analysis

In addition to the estimated economic effects of differing levels of uranium development under each alternative, effects on the tourism-related economy, recreation benefits, existence value and the economic value of ecological services are also discussed (see also Section 3.16). The recreation benefits discussion reflects the monetary value of the benefit that local residents and visitors derive from recreational activities (nonconsumptive and hunting), over and above the economic activity that tourism generates in the study area. The existence value and value of ecological services reflects the value that people place on the sheer existence of a unique resource, such as Grand Canyon National Park, and the value of the ecological services that a large, pristine wilderness like the Grand Canyon provides, such as supporting an abundant variety of species and protecting water quality.

Cumulative impacts for the Proposed Action and each alternative are discussed and include the economic impacts of each action alternative in combination with other proposed, existing, or reasonably foreseeable developments.

Tables 4.17-1 and 4.17-2 provide definitions of impact magnitude and duration, respectively, as they relate to economic conditions.

Table 4.17-1. Magnitude and Degrees of Effects on Economic Conditions

Attribute of Effect	Description Relative to Economic Conditions
Magnitude	
No Impact	Would not produce quantifiable changes in existing economic activity, taxes and revenues, recreation benefits, existence value, road condition and maintenance costs, or energy resources.
Minor	Mining-related impacts on economic activity, taxes and revenues, recreation benefits, existence value, road condition and maintenance costs, or energy resources. Minor effects would represent a low level of change which would not noticeably alter existing conditions.
Moderate	Impacts on economic or fiscal conditions that would noticeably affect conditions for at least some residents, employees, government entities or other stakeholders.
Major	Mining-related impacts that would create a high degree of change in economic or fiscal conditions, recreation benefits, existence value, road conditions and maintenance costs or energy resources.

Table 4.17-2. Duration Definition of Effects on Economic Conditions

Duration	
Short-term	Less than 5 years
Long-term	Greater than 5 years

4.17.2 Incomplete or Unavailable Information

Specific Geographic Distribution of Economic Effects

As noted earlier, the study area for economic analysis was divided into two separate sub-areas (the North Study Area, north of the Grand Canyon, and the South Study Area). The locations of projected mining activity by withdrawal area, and the location of the existing mill in Blanding, make it possible to estimate the distribution of economic effects between these two sub areas. It is not possible, however, to quantitatively estimate the further distribution of economic effects to individual counties and municipalities within each of the two sub areas. A more detailed geographic distribution of economic effects would require specific information such as where future miners would choose to live and from which companies (in which locations) mining companies would purchase goods and services, all of which would be purely speculative at this point. However, qualitative judgments regarding the affected areas likely to be most affected are provided within the effects analysis of each alternative.

Future Uranium Price Trends and Price Variability

Interest in uranium mining in the Proposed Withdrawal Areas, and elsewhere, is primarily driven by the economics of global uranium supply and demand. As shown in Figure B-4 in Appendix B (the RFD), from 1995 through early 2005, uranium prices were below $20 per pound. During that time period, little or no uranium exploration or development activity occurred in the study area. Beginning in early 2005, uranium prices spiked to over $100 per pound and there was a substantial resurgence of interest in uranium mining within the study area.

Prices have since declined to about $40 per pound. During development of the RFD, there was substantial work done to evaluate potential future uranium prices, including consultation with the Energy Information Administration (which produces official energy forecasts for the U.S.). The RFD projected future uranium prices would remain at approximately $40 per pound (in 2010 dollars).

Uranium prices have historically been volatile and it is not possible to predict the future price of uranium over the 20 year study period with a high degree of confidence. If uranium prices over the next 20 years are, on average, substantially higher than $40 per pound, these price levels would likely lead to increased interest in mining within the study area and could make some uranium resources become economical to mine that would not be economically viable at $40 per pound (increasing economically recoverable reserves). On the other hand, if uranium prices over the next 20 years are substantially lower than $40 per pound, there is likely to be diminished interest in mining within the study area. Additional discussion of the effects of alternative future pricing levels is provided under the analysis of effects for each alternative.

Predicting future pricing cycles is even more difficult than projecting average uranium prices in the future. Consequently the RFD, like most long-term forecasts of this type, did not attempt to predict future variability in prices. The economic analysis provides an estimate of the average annual economic effects of mining under the assumption that prices remain constant (in 2010 dollars). However, given the history of uranium prices and activity in the study area, it is reasonable to assume that prices will vary considerably during the next 20 years. Mining-related activity is likely to fluctuate in a corresponding fashion—during periods of relatively high prices, annual economic activity would likely exceed the projections provided in this analysis, while during periods of relatively low prices mines may cease active production and move into periods of interim management. During such times, annual economic activity would be lower than the projections provided in this analysis. In areas that rely heavily on resource extraction to support their economies, this phenomenon is sometimes referred to as the “boom-bust cycle.” Such cyclical fluctuations are difficult or impossible to predict and can substantially affect local communities and local governments.

Existence Value and Economic Value of Ecological Services

Although the 1995 study discussed in Section 3.16 demonstrated that there is a large existence value associated with the Grand Canyon, no studies exist to provide information on if, or how much, that value might be changed by an activity such as uranium mining in the surrounding area.

Publicity and media attention regarding uranium mining in the vicinity of the Grand Canyon might have some effect on the existence value that people place on the Canyon. Absent some unforeseen major event, such effects seem likely to be temporary in nature. Without a specific study focused on this issue, it is not possible to quantify potential effects of the alternatives on the existence value of the Canyon.

Grand Canyon National Park is not only a stunning natural wonder enjoyed by more than 4 million tourists each year, it is also one of the largest areas of pristine wilderness in the Southwest (and in the lower 48 states). In its natural condition, the Canyon supports numerous species of flora and fauna, which are the subject of other parts of this EIS. The Colorado River is also one of the most important river systems in the United States and is heavily relied on by a large portion of the population of the southwest for public drinking water, agricultural production and other services.

While economists are beginning to develop tools to estimate the monetary value of some ecosystem services, these tools are far from ready for the daunting task of placing a monetary value on the services provided by an area as complex as the Grand Canyon. We cannot provide any quantitative estimate of how such values might be affected by future uranium mining in the region.

4.17.3 Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, the proposed withdrawal areas would not be withdrawn from entry and location of new mining claims. As described in the RFD (see Appendix B), it is estimated that there would be as many as 26 new mines that might be developed within the proposed withdrawal areas, combined with the four existing mines, for a cumulative total of 30 mines in operation over the 20 year period. It is estimated that the existing and new mines could produce up to 79 million pounds of uranium over the 20 year period (see Appendix B). Based on the assumed price of $40 per pound, the cumulative value of production over the 20-year period (including value added through hauling and milling) would be approximately $3.16 billion (in 2010 dollars).

Regional Economic Effects under Alternative A

NORTH STUDY AREA

Approximately 60.4 million pounds of the projected cumulative production of uranium under Alternative A (76% of the total) would be anticipated to be mined from the proposed north withdrawal parcel and the proposed east withdrawal parcel, both located in the North Study Area (see Appendix B). Average annual production within the North Study Area over the 20 year period would be about 3.02 million pounds. Excluding the 15% of the value estimated to be added during the milling process (as discussed previously), at a price of $40 per pound the average annual output from uranium mining in the North Study Area would be almost $103 million (2010 dollars).

As discussed in the RFD, all uranium mined from both the North Study Area and the South Study Area is anticipated to be milled at the White Mesa Mill, located in the North Study Area. Including the projected annual uranium production of 0.95 million pounds from the South Study Area (proposed south withdrawal parcel), the average annual value added from milling under Alternative A is projected to be over $23 million (2010 dollars).

Projected Average Annual Economic Effects

Combining the annual value from mining and milling, uranium production under Alternative A is projected to directly increase regional economic output in the North Study Area by approximately $127 million per year. This projected increase in annual economic output from the mining sector was incorporated into the IMPLAN model developed for the North Study Area to estimate direct and indirect effects on value-added, employment and earnings.

Table 4.17-3 depicts the projected, average annual overall effects of uranium mining on the economy of the North Study Area under Alternative A. Uranium mining operations in the North Study Area are projected to provide about 235 direct jobs per year and almost $18 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining activities are projected to support about 513 total jobs and labor compensation of approximately $29 million in the North Study Area under Alternative A.

Table 4.17-3. Overall Average Annual Effects from Uranium Mining in North Study Area (Alternative A)

Annual Economic Effects	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Direct Effect	$126.0	235	$17.7	$87.7
Indirect Effect	$36.3	119	$6.6	$22.5
Induced Effect	$14.6	159	$4.7	$8.7
Total Effect	**$176.9**	**513**	**$29.0**	**$119.0**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Total Job Distribution by Sector

The annual total jobs in the North Study Area projected to be supported by uranium mining under Alternative A are broken down by sector in Table 4.17-4. By far, the largest number of total jobs would be in mining (which includes uranium milling under the North American Industry Classification System). The other sectors projected to experience the largest employment effects include health and social services; retail trade; finance and insurance; and accommodation and food services.

Assessment of Economic Effects of Mining in the North Study Area under Alternative A

The addition of over 500 jobs would benefit the economy of the North Study Area, particularly in the current economic climate of high unemployment. The direct jobs, in particular, would also be high-paying positions with average labor compensation (including benefits) of about $75,000 per year (2010 dollars).

Table 4.17-4. Distribution of North Study Area Total Employment Effect by Sector (Alternative A)

NAICS Sector		Total Jobs*
11	Agriculture, Forestry, Fishing, and Hunting	2
21	Mining	282
22	Utilities	8
23	Construction	3
31–33	Manufacturing	3
42	Wholesale Trade	10
44–45	Retail Trade	32
48–49	Transportation and Warehousing	14
51	Information	4
52	Finance and Insurance	21
53	Real Estate and Rentals	19
54	Professional, Scientific, and Technical Services	19
55	Management of Companies	4
56	Administrative and Waste Services	9
61	Educational Services	4
62	Health and Social Services	34
71	Arts, Entertainment, and Recreation	6
72	Accommodation and Food Services	21
81	Other Services	15
92	Government and non-NAICs	4
Total		**513**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

As documented in Chapter 3, in 2009 total value-added in the North Study Area was nearly $4 billion and there were approximately 83,000 total jobs in the North Study Area as a whole. Relative to these overall metrics, uranium mining under Alternative A would increase North Study Area value added (gross regional product) by almost 3% and increase employment by less than 1%. From the standpoint of the North Study Area as a whole, this would likely represent a moderate economic benefit.

The economic effects from uranium mining would not, however, be equally distributed across the North Study Area as a whole. It is likely that much of the direct economic effect would be concentrated in or near the communities most proximate to the proposed north withdrawal parcel (Fredonia, Kanab, the Kaibab Paiute Tribe, and Colorado City), and in Blanding where the uranium is projected to be processed. In these areas, Alternative A could produce moderate to major economic benefits over the next 20 years. It should be noted, however, that the RFD (see Appendix B) projects the mineable uranium resources in the North Study Area to be exhausted by the end of the 20 year period considered in this EIS. At that point, the uranium mining related jobs and economic benefits under Alternative A would cease.

Effects of Alternative Future Prices and Price Variability

As discussed earlier in this section, future uranium prices are uncertain. If future prices are, on average, considerably higher than the $40 per pound assumed in the RFD, the amount of mineable uranium resources might be greater than estimated in the RFD. However, since the RFD also assumes that industry capacity limitations would restrict uranium production in the overall study area (North Study Area and

South Study Area combined) to no more than six mines in operation at any one time, the primary effect of higher prices could be to allow uranium production to continue beyond the 20 year timeframe evaluated in this EIS.

The RFD assumption that industrial capacity will limit the number of producing uranium mines in the three proposed withdrawal areas to no more than six at any one time is a critical assumption in terms of the economic effects analysis. If that assumption does not prove to be accurate, the pace of uranium development could be faster than estimated. This would lead to larger short-term economic benefits related to uranium-production, but would also hasten the end of active production (and the subsequent loss of uranium-related jobs in the study area). A faster pace of development would also increase the likelihood of impacts on tourist visitation in the area and increase the potential for negative effects on the tourism-related economy.

Uranium prices have historically been highly variable. It is likely that regardless of the future average price of uranium, there will be considerable fluctuation and periods of relatively high and relative low prices. This could lead to “boom” periods where economic activity levels are substantially higher than the average annual estimates provided previously and “bust” periods where activity is greatly diminished. These types of cycles can create considerable challenges for small economies, such as the communities likely to be most affected by uranium development in the North Study Area.

Effects on Regional Tourism Economy

As discussed in Chapter 3, tourist visits to National Parks and Nation Monuments support more than 8,300 jobs in the North Study Area. Visits to the North Rim of the Grand Canyon account for almost 2,000 of those jobs.

Conflicts are likely to arise between some visitors and uranium mining activity under Alternative A. Some visitors will experience traffic congestion in driving to or from the Grand Canyon or other major attractions in the region due to ore hauling. Other tourists may have their visit to Toroweap Point affected by the sights or sounds of uranium mining activity. Such incidents may lead these families to not make a return visit, or to discourage their neighbor from choosing the Grand Canyon as a vacation destination. Potentially, some peoples’ perception of the Grand Canyon could also be affected by news about uranium mining in the vicinity, particularly if any high profile incidents were to occur.

Conceptually, potential tourist behavioral responses could be projected on the basis of surveys about their anticipated behavior under the uranium development scenarios envisioned under each alternative. However, developing reliable estimates from such surveys could be difficult, especially given the politically charged atmosphere surrounding this proposed action. No such surveys are currently available. It is known is that substantial mining activity did occur in the region in 1980s, coincident with ongoing increases in tourist visits to the Grand Canyon (personal communication, Matt Brown, Kane County Economic Development Director 2011).

The estimate of the effects of Alternative A, and the other alternatives, on the tourism-related economy relies on the recreation effects analysis (see Section 4.15). That analysis concluded that effects on visitation would likely be minor. The same would apply to the tourism-related economy.

SOUTH STUDY AREA

Approximately 18.9 million pounds of the projected cumulative production of uranium under Alternative A (24% of the total) would be anticipated to be mined from the proposed south withdrawal parcel, located in the South Study Area. Average annual production within the South Study Area over the 20-year period would be about 0.95 million pounds. Excluding the 15% of the value estimated to be added during the milling process (which would accrue to the North Study Area), at a price of $40 per pound the average annual output from uranium mining in the South Study Area would be about $32 million (2010 dollars).

Projected Average Annual Economic Effects

The projected $32 million increase in average annual economic output from the mining sector was incorporated into the IMPLAN model developed for the South Study Area to estimate direct and indirect effects on value-added, employment and earnings.

Table 4.17-5 depicts the projected, average annual overall effects of uranium mining on the economy of the South Study Area under Alternative A. Uranium mining operations in the South Study Area are projected to provide about 60 direct jobs per year and about $3.4 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining activities are projected to support about 123 total jobs and labor compensation of approximately $6.2 million in the South Study Area under Alternative A.

Table 4.17-5. Overall Average Annual Effects from Uranium Mining in South Study Area (Alternative A)

Annual Economic Effects	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Direct Effect	$32.0	60	$3.4	$16.7
Indirect Effect	$8.1	32	$1.7	$4.5
Induced Effect	$3.4	31	$1.1	$2.0
Total Effect	**$43.5**	**123**	**$6.2**	**$23.3**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Total Job Distribution by Sector

The annual total jobs in the South Study Area projected to be supported by uranium mining under Alternative A are broken down by sector in Table 4.17-6. The largest number of total jobs would be in mining. The other sectors projected to experience the largest employment effects include health and social services; retail trade; professional, scientific and technical services; and accommodation and food services.

Table 4.17-6. Distribution of South Study Area Total Employment Effect by Sector (Alternative A)

NAICS	Sector	Total Jobs*
11	Agriculture, Forestry, Fishing, and Hunting	1
21	Mining	70
22	Utilities	2
23	Construction	1
31–33	Manufacturing	1
42	Wholesale Trade	2
44–45	Retail Trade	7
48–49	Transportation and Warehousing	4
51	Information	1
52	Finance and Insurance	3
53	Real Estate and Rentals	2

Table 4.17-6. Distribution of South Study Area Total Employment Effect by Sector (Alternative A), Continued

NAICS Sector		Total Jobs*
54	Professional, Scientific, and Technical Services	6
55	Management of Companies	1
56	Administrative and Waste Services	3
61	Educational Services	1
62	Health and Social Services	8
71	Arts, Entertainment, and Recreation	1
72	Accommodation and Food Services	5
81	Other Services	4
92	Government and non-NAICs	1
Total		**123**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

Assessment of Economic Effects of Mining in the South Study Area under Alternative A

The addition of over 120 jobs would benefit the economy of the South Study Area, particularly in the current economic climate of high unemployment. As in the North Study Area, the direct jobs would be relatively high paying positions.

As documented in Chapter 3, in 2009 total value-added in the South Study Area was over $8 billion and there were almost 149,000 total jobs in the South Study Area as a whole. Relative to these overall metrics, uranium mining under Alternative A would increase annual South Study Area value added (gross regional product) by less than 0.3% and increase employment by less than 0.1%. From the standpoint of the South Study Area as a whole, this would represent a minor benefit.

As in the North Study Area, the economic effects of uranium mining would likely not be equally distributed across the South Study Area. Tusayan is the only community located within (or in close proximity to) the proposed south withdrawal parcel. Within a few miles of the heavily visited South Entrance to Grand Canyon National Park, the economy in Tusayan is focused almost entirely on tourism. The newly incorporated town appears unlikely to serve as a base for mining activity in the proposed south withdrawal area. More likely, the base of mining activity in the South Study Area would be more widely distributed further from the proposed withdrawal area in larger communities such as Flagstaff and Williams.

Effects of Alternative Future Prices and Price Variability

If future uranium prices are, on average, considerably higher than the $40 per pound assumed in the RFD, the amount of mineable uranium resources in the proposed south withdrawal area might be greater than estimated in the RFD. As discussed previously for the North Study Area, the primary effect of higher prices could be to allow uranium production to continue beyond the 20 year timeframe evaluated in this EIS.

As discussed earlier, based on historical experience future uranium prices are likely to be highly variable and could lead to considerable variation in uranium mining activity over the 20 year study period. Such cycles would not be expected to cause substantial economic instability in the South Study Area given the relative small projected economic effects in this area.

Effects on Regional Tourism Economy

Tourist visits to National Parks and Nation Monuments supported nearly 12,900 jobs in the South Study Area in 2008. Visits to the South Rim of the Grand Canyon account for more than 9,600 of those jobs (see Section 3.15).

As discussed previously for the North Study Area, the possibility of impacts on visitor use at the Grand Canyon due to uranium exploration and production cannot be dismissed. Some impacts to the visitor experience, and potentially to visitor use, could occur due to the presence of heavy haul trucks on access roads, noise and visual intrusion. However, the recreation analysis (see Section 4.15) has estimated that overall impact to visitor use under Alternative A would be minor. Given that most uranium mining related activity is anticipated to occur in the North Study Area, there would likely be no effect or a minor effect on the tourism economy in the South Study Area under Alternative A.

Effects on Taxes and Revenues under Alternative A

The projected uranium mining activity under Alternative A would produce additional revenues for the federal government, for the State of Arizona and the State of Utah, and for local governments in the study area. The primary sources of additional revenues would include federal and state income-related taxes, state severance taxes (in Arizona only), state and local sales-related taxes and local property taxes. Although the mines would be located on federal lands they would be subject to centrally assessed property taxes based on the present value of the discounted cash flow of their operations. Denison Mines, which owns and operates the White Mesa Mill in San Juan County (where uranium mined from the proposed withdrawal areas would be anticipated to be processed), is currently one of that county's largest taxpayers (personal communication, Rick Bailey 2011). Unlike some other forms of resource extraction, uranium mining on federal lands is not subject to federal royalty payments.

Projected tax and revenue effects are presented below on an average annual basis, in constant 2010 dollars.

NORTH STUDY AREA

Federal Revenues

Under Alternative A, the projected increase in total annual output of about $177 million per year resulting from uranium mining and processing in the North Study Area would produce an estimated average of $8.9 million per year in revenues for the federal government. This total includes a projected $3.4 million per year in contributions to social insurance programs (social security and Medicare), an estimated $4.1 million per year in personal income and corporate profit taxes and approximately $1.4 million per year in indirect, federal business taxes. Indirect business taxes include excise taxes, fees, fines, and revenue from sales of licenses and permits.

State Revenues

Annual uranium production in the North Study Area would produce an estimated $1.2 million in state income tax revenues and a projected $3 million per year in state sales tax revenues.[22] These $4.2 million in combined state revenues would be divided between the State of Arizona and the State of Utah,

[22] The IMPLAN model does not separate projected sales tax revenues between state and local governments. Based on analysis of data for the 2010 fiscal year, local governments in Arizona portions of the study area receive approximately 44 cents from every dollar of sales taxes collected, while local governments in Utah receive about 29 cents from each sales tax dollar. Since the future distribution of taxable sales in the North Study Area between Arizona and Utah is unknown, a local government share of 35 cents per dollar was assumed for this analysis.

depending on where uranium miners (and the indirect workers supported by uranium production) live and work and the locations where taxable sales occur.

Net of value added during the milling process (which is not subject to severance taxes), the annual direct value added by uranium mining in the North Study Area under Alternative A is estimated at approximately $71 million. Applying the State of Arizona's 2.5% severance tax to 50% of this value added estimate (as specified in current statute) results in a projected annual average of about $0.9 million per year in severance tax revenues. About 80% of Arizona severance tax revenues are distributed back to cities and counties throughout the state based on the same distribution formula used for state collected transaction privilege taxes (Arizona Department of Revenue 2010).

Local Government Revenues

Local governments in the North Study Area would receive a projected total of $1.6 million per year in sales-related taxes.[23] They would also receive an estimated $3.4 million per year in property taxes.

Summary and Assessment of Taxes and Revenues under Alternative A from North Study Area Activity

Table 4.17-7 summarizes projected annual federal, state and local tax revenues resulting from uranium production in the North Study Area under Alternative A. Under Alternative A, total government revenues are projected to be approximately $19.0 million per year. Annual state government revenues are projected at $5.1 million, and state revenues from income and sales-related taxes would be divided between the State of Arizona and the State of Utah. Local government revenues are projected at about $5.0 million per year.

Table 4.17-7. Projected Annual Government Revenues from Alternative A Uranium Production in the North Study Area (in millions of 2010 dollars)

Revenue Types and Recipients	
Federal Tax Revenues	
Social Insurance Programs	$3.4
Income and Profits Taxes	$4.1
Indirect Business Taxes	$1.4
Subtotal	*$8.9*
State Tax Revenues	
Severance Taxes	$0.9
Income Taxes	$1.2
Sales-Related Taxes	$3.0
Subtotal	*$5.1*
Local Government Revenues	
Sales-Related Taxes	$1.6
Property Taxes	$3.4
Subtotal	*$5.0*
Total Government Revenues	**$19.0**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

[23] See footnote above.

The description of the economics affected environment (Section 3.17) documented the declines in state and local revenues that have occurred since the recession began in 2008. Federal revenues have declined in a similar fashion. In the current fiscal environment, any additional government revenues would be beneficial. Relative to the overall scale of the federal government, however, an increase in revenues of $8.9 million per year would be considered a minor benefit. The same holds true for the additional state government revenues that could be collected under Alternative A.

At the local level, the additional $5.0 million per year in government revenues that could occur under Alternative A would represent a minor to moderate benefit for county governments in the study area. The additional local tax revenues could, however, represent a larger relative benefit for some of the smaller communities that might be most directly affected, such as Fredonia, Kanab, Colorado City and Blanding. At least some portion of the additional local revenues could, however, be partly offset by additional costs for road maintenance (discussed later), emergency response services and the costs of providing other government services such as education, police and fire protection to new residents and businesses.

SOUTH STUDY AREA

Federal Revenues

Under Alternative A, the projected annual output of about $44 million per year from uranium mining in the South Study Area would produce an estimated average of $1.7 million per year in revenues for the federal government. This total includes a projected $0.7 million per year in contributions to social insurance programs (social security and Medicare), an estimated $0.8 million per year in personal income and corporate profit taxes and approximately $0.2 million per year in indirect, federal business taxes. Indirect business taxes include excise taxes, fees, fines, and revenue from sales of licenses and permits.

State Revenues

Annual uranium mining in the South Study Area would produce an estimated $0.2 million in state income tax revenues and a projected $0.6 million per year in state sales tax revenues for the State of Arizona.

The annual direct value added by uranium mining in the South Study Area under Alternative A is estimated at approximately $17 million. Applying the State of Arizona's 2.5% severance tax to 50% of this value added estimate results in a projected annual average of about $0.2 million per year in severance tax revenues. About 80% of Arizona severance tax revenues are distributed back to cities and counties throughout the state, based on the same distribution formula used for state collected transaction privilege taxes (Arizona Department of Revenue 2010).

Local Government Revenues

Local governments in the South Study Area would receive a projected total of $0.5 million per year in sales-related taxes and $0.7 million per year in property tax revenues.

Summary and Assessment of Taxes and Revenues under Alternative A from South Study Area Activity

Table 4.17-8 summarizes projected annual federal, state and local tax revenues resulting from uranium mining in the South Study Area under Alternative A. Under Alternative A, total government revenues are projected to be approximately $3.9 million per year. Annual state government revenues are projected at $1.0 million. Local government revenues are projected at about $1.2 million per year.

The projected increase in federal revenues of $1.7 million per year and the projected increase in revenues for the State of Arizona of $1.0 million would be considered a minor benefit for both entities.

At the local level, the additional $1.2 million per year in government revenues that could occur under Alternative A would represent a minor benefit for county governments and city governments in the study area. At least some portion of the additional local revenues could, however, be partly offset by additional costs for road maintenance (discussed later), emergency response services and the costs of providing other government services such as education, police and fire protection to new residents and businesses.

Table 4.17-8. Projected Annual Government Revenues from Alternative A Uranium Production in the South Study Area (in millions of 2010 dollars)

Revenue Types and Recipients	
Federal Tax Revenues	
Social Insurance Programs	$0.7
Income and Profits Taxes	$0.8
Indirect Business Taxes	$0.2
Subtotal	*$1.7*
State Tax Revenues	
Severance Taxes	$0.2
Income Taxes	$0.2
Sales-Related Taxes	$0.6
Subtotal	*$1.0*
Local Government Revenues	
Sales-Related Taxes	$0.5
Property Taxes	$0.7
Subtotal	*$1.2*
Total Government Revenues	**$3.9**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

RECREATION AND ENVIRONMENTAL ECONOMICS

Nonconsumptive Recreation

Impacts to recreation in terms of visitor use, recreation opportunities, and recreation settings and experiences are analyzed in Section 4.15. This analysis discusses how changes in visitor use, if any, evaluated in Section 4.15 may result in changes in the associated economic benefits received by recreation users. As previously noted (see Section 3.17.1), the total estimated annual benefit of recreation sites in and near the proposed withdrawal areas is approximately $450 million (see Table 3.17-25 and Table 3.17-26), with the Grand Canyon National Park accounting for most of this value. As stated in Section 4.15, the overall impact to visitor use under Alternative A (through changes in recreation opportunities or desired experiences) would be minor. These minor impacts would be expected to result in no more than minor changes in the annual economic benefits of recreation.

Hunting

As previously noted (see Section 3.17), the total estimated annual benefit of hunting activities in the study area is $1.53 million (see Table 3.17-27). The total land area for the four GMUs (9, 12A, 12B, and 13A) considered in the study area cover more than 3.2 million acres. As described in Section 4.7, effects of Alternative A on critical winter range are expected to be minimal and impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent.

Under Alternative A, if the full RFD scenario is realized, the total estimated ground disturbance is 1,364 acres over a 20-year period for all phases (exploration, mines, roads, and power lines), or an average of 68 acres per year. Thus, in the context of the overall available hunting area, compared with the small amount of ground disturbance, mineral activity is unlikely to result in measurable impacts to hunters, or the associated total estimated annual benefit of hunting.

Economic Aspects of Environmental Quality at Grand Canyon National Park

As noted in Section 3.17, a 1995 study estimated the existence value of the Grand Canyon at between $2.3 billion and $3.4 billion per year (Welsh et al. 1995). Other previous studies discussed in Chapter 3 (see Section 3.17) demonstrate the public's estimated willingness to pay to avoid a reduction in air quality (and particularly visibility) at the Grand Canyon. These studies (see Section 3.17) also concluded that 80% of visitors indicated they would shorten their stay at the Grand Canyon if visibility was reduced. This previous research demonstrates visitor sensitivity to changes in environmental quality at the Grand Canyon. If there were perceptible changes in water, visual, and/or soundscape quality, it is possible that such changes in other environmental attributes of the Grand Canyon could also have quantifiable effects.

Section 4.2 states that changes in air quality from mineral activity (exploration and mine development) would result primarily from vehicle/equipment and fugitive dust emissions for access and ore hauling. Additionally, because these emissions would occur at ground level, it is unlikely that emissions would be transported more than a few kilometers, except on windy days and during significant wind events; mitigation measures discussed in Section 4.2 would be expected to reduce these impacts. Thus, no measurable reduction in air quality is expected.

Section 4.9 states that impacts on visual resources vary according to the location of the facilities and could range from minor to major impacts. Impacts from noise caused by mining equipment operation are dependent on a variety of factors, including the proximity of the mining activity to the Park boundary and access routes, the type of equipment used, the topography of the area, direction of the prevailing wind, and hours of equipment operation (see Section 4.10). Impacts on water resources also range from minor to major and are discussed further in Section 4.4.

There has been no update to the 1995 existence value study, and no study that has attempted to evaluate how the existence value might be affected by uranium mining activity in the surrounding region. Without a specific study focused on this issue, it is not possible to quantify potential effects of Alternative A, or the other alternatives, on the existence value of the Canyon.

As noted earlier in this section, it is also not possible to provide a quantitative, monetary estimate of any changes in the value of ecological services provided by the Grand Canyon under any of the alternatives.

ENERGY RESOURCES

Under Alternative A, 39,666 tons (79 million pounds) of uranium are projected to be produced from the proposed withdrawal area over the 20 year period, reflecting an annual average of nearly 4 million pounds of production. Over the past twenty years U.S. production has averaged 4.4 million pounds per year but during peak production in the 1960s-1980s the annual average was 28 million pounds (EIA 2011b).

In 2010, U.S. operators purchased 47 million pounds of uranium oxide equivalent, of which 91% was imported and 8% was of U.S. origin. Domestic demand is generally projected to rise over the next decade, fluctuating between 46 and 56 million pounds through 2020 (EIA 2010c) for a total growth of 15%. Global demand is also expected to rise, with a projected increase of 33% between 2010 and 2020 and 16% from 2020 to 2030 (World Nuclear Association 2010b). These forecasts were developed prior to the nuclear power crisis in Japan following the tsunami. The effects of this crisis on global or national demand remain uncertain at this time.

Current U.S. production (4.2 million pounds in 2010) meets 9% of domestic demand. Thus, the additional production from the withdrawal under Alternative A could meet about 8% of current U.S. demand and increase total domestic production to the equivalent of 17% of annual U.S. demand (though uranium produced from the proposed withdrawal areas would not necessarily be entirely purchased and used to produce electricity in the United States). World production of uranium was approximately 118 million pounds in 2010, so projected annual uranium production under Alternative A could increase global production of uranium by almost 4%.

Based on the projections developed for the RFD, Alternative A would have a major long-term beneficial effect on U.S. uranium production. Given that nuclear power accounted for approximately 21% of U.S. electric generation in 2009 (EIA 2010b), Alternative A would have a moderate long-term beneficial effect on overall U.S. energy resources.

ROAD CONDITION AND MAINTENANCE

Under Alternative A, 22.4 miles of new roads would be constructed, 83.9% (18.8 miles) would be constructed on BLM lands within the North and East parcels. An estimated 317,505 haul trips would occur on area roads over the 20-year time frame (see Appendix B), or an average of about 15,875 haul trips per year (about 51 trips per day assuming a six day per week schedule) under this alternative. An estimated 70% of the haul trips (221,298) would originate from the proposed north withdrawal area, 7% (22,240) from the proposed east withdrawal area, and 23% (73,967) from the proposed south withdrawal area.

The addition of 18.8 miles of new roads would represent an increase of 0.28% of the BLM transportation system of primary, secondary, and tertiary unpaved roads. Construction of 3.6 miles of new roads on Forest Service lands in the South Parcel would represent an increase of 0.49% of the 740 miles of roads open to motorized travel on the Kaibab National Forest.

Mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore. Consequently, no effects on public costs to maintain unpaved roads are expected.

In general, the addition of approximately 51 haul trips per day on county and state roads and U.S. highways is not expected to have a significant effect on maintenance requirements or costs, given the volume of traffic that already occurs on these roads. The largest percentage change in traffic volume would be projected to occur on U.S. Routes 89A, 191, and 160 in Arizona, and U.S. Route 191 in Utah, where traffic volumes could be increased by up to 2.09%–3.55% per year due to hauling traffic.

Coconino County has indicated a potential concern regarding use of Arizona State Highway 98, which crosses the northwest portion of the Navajo Reservation from Page to connect to U.S. Route 160 southeast of Kayenta. This road would likely be used by many of the haulers as their most direct route. Coconino County has indicated that the road is a light duty road, with minimal or no shoulders in places and is not well suited to heavy truck traffic. Coconino County has experienced problems with trucks using the road in the past, and is concerned that it will need to be upgraded if it is widely used for ore hauling (personal communication, Carl Taylor and Bill Towler, Coconino County 2011). These concerns have been disputed by other cooperating agencies and have not been independently evaluated by the third party EIS team.

In Section 4.16, data from the USDOT regarding the frequency of rollover trucking accidents was used, in conjunction with projections of the number of ore hauling trips and the mileages involved in each trip, to estimate the potential number of rollover accidents and ore spills over the 20 year span of the study period. Under Alternative A, an average of about 1.4 rollover accidents and spills per year was projected. The hauling industry is generally responsible for cleaning up these types of accidents. However, a 2005 study in Washington State documented the costs of follow-up remediation for uranium ore spills along public roads. That study put the cost of follow-up cleanup and remediation for 12 spills at approximately $360,000 (MFG, Inc. 2005). In 2010 dollars, this implies an average cost of cleanup of about $33,000 per spill, or a projected annual cost of about $46,000 to clean up the 1.4 spills per year projected under Alternative A. The type of follow-up cleanup and remediation that occurred in Washington State may or may not be applicable to hauling in Northern Arizona and Southern Utah. These costs were paid by the mining company responsible for the spills.

Overall, under Alternative A, there would be no impact or a minor impact to road maintenance costs.

Cumulative Impacts

Past and present land uses in the economic study area have had a direct effect on economic conditions through changes to employment (both types and amount) and revenue generated through various actions within the region. Past and present actions have resulted in the current economic conditions in the study area, as described in Section 3.17.

Past actions that have affected economic conditions in the region by increasing recreational use and tourist visitation to the area include issuances of special recreation permits for jeep, hiking, and biking tours on the North and East parcels and commercial and residential development in the area to accommodate population growth. Existing projects and events that are present in the proposed withdrawal area related to economic conditions include mineral development and recreation. Reasonably foreseeable future projects and events for the proposed withdrawal area include adjustments for increased regional and community population growth and land tenure adjustments by both the BLM and Forest Service. As described elsewhere in this chapter, reasonably foreseeable future projects in the area include those that would enhance regional transportation systems and recreational areas such as the Four Forest Restoration Initiative, Tusayan’s and North Kaibab’s Travel Management Projects, and the Greenway Trail and Parking Lot. Projects such as these would impact the region’s economy by attracting more visitors.

The direct and indirect economic effects of Alternative A, as described in the preceding pages, are expressed in terms of the incremental effects of the alternative on the economic conditions in the study area. Other changes in the population and economy of the study area over the 20 year proposed withdrawal period, such as ongoing economic and population growth in some communities, would not substantially alter these incremental effects. Overall, cumulative effects to economic conditions under Alternative A are anticipated to be essentially the same as the direct and indirect impacts discussed previously.

4.17.4 Impacts of Alternative B: Proposed Action and Preferred Alternative (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, federal lands within the proposed withdrawal areas would be withdrawn from entry and location of new mining claims. As described in the RFD (see Appendix B), it is estimated that up to 7 new mines might be developed within the proposed withdrawal areas (based on the assumption that they have valid existing claims), combined with the four existing mines, for a cumulative total of 11 mines in operation over the 20 year period. It is estimated that the existing and new mines could produce up to 21 million pounds of uranium over the 20-year period (see Appendix B). Based on the assumed price of $40 per pound, the cumulative value of production over the 20 year period (including value added through hauling and milling) would be approximately $840 million (in 2010 dollars).

Regional Economic Effects Under Alternative B

NORTH STUDY AREA

Approximately 19.4 million pounds of the projected cumulative production of uranium under Alternative B (90% of the total) would be anticipated to be mined from the proposed north withdrawal parcel and the proposed east withdrawal parcel, both located in the North Study Area (see Appendix B). Average annual production within the North Study Area over the 20-year period would be about 0.97 million pounds. Excluding the 15% of the value estimated to be added during the milling process (as discussed in the initial part of this section), at a price of $40 per pound the average annual output from uranium mining in the North Study Area would be about $33 million (2010 dollars).

As discussed in the RFD, all uranium mined from both the North Study Area and the South Study Area is anticipated to be milled at the White Mesa Mill, located in the North Study Area. Including the projected annual uranium production of 0.10 million pounds from the South Study Area (proposed south withdrawal parcel), the average annual value added from milling under Alternative B is projected to be about $6 million (2010 dollars).

Projected Average Annual Economic Effects

Combining the annual value from mining and milling activities, uranium production under Alternative B is projected to directly produce approximately $39 million per year in economic output in the North Study Area. This projected increase in annual direct economic output from the mining sector was incorporated into the IMPLAN model developed for the North Study Area to estimate direct and indirect effects on value-added, employment and earnings.

Table 4.17-9 depicts the projected, average annual overall effects of uranium mining on the economy of the North Study Area under Alternative B. Uranium mining operations in the North Study Area are projected to provide about 73 direct jobs per year and about $5.5 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining activities are projected to support about 159 total jobs and labor compensation of approximately $9 million in the North Study Area under Alternative B. Relative to Alternative A, this alternative is projected to result in about 354 fewer jobs per year (combining direct and indirect effects) and about $82 million less in gross regional product (value-added).

Table 4.17-9. Overall Average Annual Effects from Uranium Mining in North Study Area (Alternative B)

	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Annual Economic Effects				
Direct Effect	$39.0	73	$5.5	$27.2
Indirect Effect	$11.2	37	$2.0	$7.0
Induced Effect	$4.5	49	$1.4	$2.7
Total Effect	**$54.8**	**159**	**$9.0**	**$36.8**
Effects Relative to Alternative A				
Direct Effect	-$87.0	-162	-$12.3	-$60.6
Indirect Effect	-$25.1	-82	-$4.6	-$15.6
Induced Effect	-$10.1	-110	-$3.2	-$6.0
Total Effect	**-$122.1**	**-354**	**-$20.0**	**-$82.1**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Total Job Distribution by Sector

The annual total jobs in the North Study Area projected to be supported by uranium mining under Alternative B are broken down by sector in Table 4.17-10. The largest number of total jobs would be in mining (which includes uranium milling under the North American Industry Classification System). The other sectors projected to experience the largest employment effects include health and social services; retail trade; and finance and insurance. The largest reduction in jobs, relative to Alternative A, would be in the mining sector – which also includes uranium milling activities.

Table 4.17-10. Distribution of North Study Area Total Employment Effect by Sector (Alternative B)

NAICS Sector		Total Jobs*	Difference from Alternative A
11	Agriculture, Forestry, Fishing, and Hunting	1	−1
21	Mining	87	−195
22	Utilities	2	−5
23	Construction	1	−2
31–33	Manufacturing	1	−2
42	Wholesale Trade	3	−7
44–45	Retail Trade	10	−22
48–49	Transportation and Warehousing	4	−10
51	Information	1	−2
52	Finance and Insurance	7	−15
53	Real Estate and Rentals	6	−13
54	Professional, Scientific, and Technical Services	6	−13
55	Management of Companies	1	−3
56	Administrative and Waste Services	3	−6
61	Educational Services	1	−3
62	Health and Social Services	11	−24

Table 4.17-10. Distribution of North Study Area Total Employment Effect by Sector (Alternative B), Continued

NAICS Sector		Total Jobs*	Difference from Alternative A
71	Arts, Entertainment, and Recreation	2	−4
72	Accommodation and Food Services	6	−14
81	Other Services	5	−10
92	Government and non-NAICs	1	−3
Total		**159**	**−354**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

Assessment of Economic Effects of Mining in the North Study Area under Alternative B

The reduction of approximately 354 jobs (relative to Alternative A) would affect the economy of the North Study Area. The projected regional economic effects in the North Study Area from uranium production under Alternative B are a little less than one-third the size of the projected effects under Alternative A.

Relative to the overall size of the North Study Area economy, the reduction in future uranium mining under Alternative B (compared to Alternative A) would decrease North Study Area value added (gross regional product) by about 2% and decrease employment by about four-tenths of one percent. From the standpoint of the North Study Area as a whole, this would likely represent a minor economic effect.

As discussed for Alternative A, the economic effects from uranium mining would likely not be equally distributed across the North Study Area as a whole. It is likely that much of the direct economic effect would be concentrated in or near the communities most proximate to the proposed north withdrawal parcel (Fredonia, Kanab, the Kaibab Paiute Tribe, and Colorado City), and in Blanding where the uranium is projected to be processed. The reduction in projected future uranium mining under Alternative B could have a moderate long-term effect on future economic conditions in at least some of these communities.

Effects of Alternative Future Prices and Price Variability

If future prices are, on average, considerably higher than the $40 per pound assumed in the RFD, the pace of allowable mining activity under Alternative B (at existing mines and mines with valid existing claims) might accelerate. During the first part of the 20 year study period, the annual economic benefits from mining might be greater than estimated in this analysis. The faster pace would, however, also accelerate the exhaustion of the existing and allowable mines, leading to the end of mining activity (and the loss of mining-related jobs) prior to the end of the study period.

Uranium prices have historically been highly variable. It is likely that regardless of the future average price of uranium, there will be considerable fluctuation and periods of relatively high and relative low prices. While this could lead to “boom” periods and “bust” periods, the effect of such cycles on the economic stability of the North Study Area would be less than under Alternative A because of the reduced scale of mining activity under Alternative B.

Effects on Regional Tourism Economy

As discussed in Chapter 3, tourist visits to National Parks and Nation Monuments support more than 8,300 jobs in the North Study Area. Visits to the North Rim of the Grand Canyon account for almost 2,000 of those jobs.

Alternative B would have the smallest potential to impact visitor use at the Grand Canyon due to uranium exploration and production. Based on the recreation effects analysis described in Section 4.15, Alternative B would be expected to result in a minor benefit in terms of visitor use (relative to Alternative A). Alternative B would be expected to also lead to a minor benefit to the tourism-related economy.

SOUTH STUDY AREA

Approximately 2.0 million pounds of the projected cumulative production of uranium under Alternative B (10% of the total) would be anticipated to be mined from the proposed south withdrawal parcel, located in the South Study Area. Average annual production within the South Study Area over the 20 year period would be about 0.1 million pounds. Excluding the 15% of the value estimated to be added during the milling process (which would accrue to the North Study Area), at a price of $40 per pound the average annual output from uranium mining in the South Study Area would be about $3 million (2010 dollars).

Projected Average Annual Economic Effects

The projected $3 million in average annual economic output from the mining sector was incorporated into the IMPLAN model developed for the South Study Area to estimate direct and indirect effects on value-added, employment and earnings. Table 4.17-11 depicts the projected, average annual overall effects of uranium mining on the economy of the South Study Area under Alternative B. Uranium mining operations in the South Study Area are projected to provide an average of 6 direct jobs per year and about $0.3 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining activities are projected to support about 12 total jobs and labor compensation of approximately $0.6 million in the South Study Area under Alternative B. These estimates of annual mining-related economic activity in the South Study Area are approximately 90% lower than under Alternative A.

Table 4.17-11. Overall Average Annual Effects from Uranium Mining in South Study Area (Alternative B)

	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Annual Economic Effects				
Direct Effect	$3.0	6	$0.3	$1.6
Indirect Effect	$0.8	3	$0.2	$0.4
Induced Effect	$0.3	3	$0.1	$0.2
Total Effect	**$4.1**	**12**	**$0.6**	**$2.2**
Effects Relative to Alternative A				
Direct Effect	−$29.0	-54	−$3.0	−$15.2
Indirect Effect	−$7.3	-29	−$1.5	−$4.1
Induced Effect	−$3.1	-29	−$1.0	−$1.8
Total Effect	**−$39.4**	**-112**	**−$5.6**	**−$21.1**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding

Total Job Distribution by Sector

The annual total jobs in the South Study Area projected to be supported by uranium mining under Alternative B are broken down by sector in Table 4.17-12. Apart from jobs in mining, uranium mining in the South Study Area is projected to indirectly support additional employment in include health and social services; retail trade; and professional, scientific and technical services. Relative to Alternative A, the largest reduction in mining-related jobs under Alternative B would be in the mining sector.

Note that the figures in Table 4.17-12 do not add to the total due to rounding.

Table 4.17-12. Distribution of South Study Area Total Employment Effect by Sector (Alternative B)

NAICS Sector		Total Jobs*	Difference from Alternative A
11	Agriculture, Forestry, Fishing, and Hunting	0	−1
21	Mining	7	−63
22	Utilities	0	−2
23	Construction	0	−1
31–33	Manufacturing	0	−1
42	Wholesale Trade	0	−2
44–45	Retail Trade	1	−6
48–49	Transportation and Warehousing	0	−4
51	Information	0	−1
52	Finance and Insurance	0	−3
53	Real Estate and Rentals	0	−2
54	Professional, Scientific, and Technical Services	1	−6
55	Management of Companies	0	−1
56	Administrative and Waste Services	0	−2
61	Educational Services	0	−1
62	Health and Social Services	1	−7
71	Arts, Entertainment, and Recreation	0	−1
72	Accommodation and Food Services	0	−4
81	Other Services	0	−4
92	Government and non-NAICs	0	−1
Total		**12**	**−112**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

Assessment of Economic Effects of Mining in the South Study Area under Alternative B

From the standpoint of the South Study Area as a whole (and even the communities potentially most affected within the South Study Area), the reduction in economic activity stimulated by uranium mining under Alternative B (compared to Alternative A) would be a minor effect. The difference of 112 jobs per year between the two alternatives would represent less than one-tenth of one percent of the current job total in the South Study Area.

Effects of Alternative Future Prices and Price Variability

Given the relatively low level of uranium mining (and corresponding economic activity) projected to occur in the South Study Area under Alternative B, alternative price scenarios or future variation in the price of uranium would have little effect on the projected economic benefits under this alternative.

Effects on Regional Tourism Economy

Under Alternative B there would be very little mining related activity in the South Study Area over the next 20 years and, based on the recreation effects analysis in Section 4.15, likely no effect on visitation to Grand Canyon National Park or the tourism economy in the South Study Area. This alternative would provide a minor benefit in these areas, relative to Alternative A.

Effects on Taxes and Revenues under Alternative B

The projected uranium mining activity under Alternative B would produce additional revenues for the federal government, for the State of Arizona and the State of Utah, and for local governments in the study area relative to existing conditions, but lower revenues than under Alternative A.

NORTH STUDY AREA

Federal Revenues

Under Alternative B, the projected total annual output of about $55 million per year resulting from uranium mining and processing in the North Study Area would produce an estimated average of $2.8 million per year in revenues for the federal government. This total includes a projected $1.1 million per year in contributions to social insurance programs (social security and Medicare), an estimated $1.3 million per year in personal income and corporate profit taxes and approximately $0.4 million per year in indirect, federal business taxes. Alternative B is projected to decrease annual federal revenues, relative to Alternative A, by about $6.1 million per year.

State Revenues

Annual uranium production in the North Study Area would produce an estimated $0.4 million in state income tax revenues and a projected $0.9 million per year in state sales tax revenues. These $1.3 million in combined state revenues would be divided between the State of Arizona and the State of Utah, depending on where uranium miners (and the indirect workers supported by uranium production) live and work and the locations where taxable sales occur.

Net of value added during the milling process (which is not subject to severance taxes), the annual direct value added by uranium mining in the North Study Area under Alternative B is estimated at approximately $23 million. Applying the State of Arizona's 2.5% severance tax to 50% of this value added estimate results in a projected annual average of about $0.3 million per year in severance tax revenues.

Local Government Revenues

Local governments in the North Study Area would receive a projected total of $0.5 million per year in sales-related taxes and $1.0 million per year in property tax revenues associated with uranium production.

Summary and Assessment of Taxes and Revenues under Alternative B from North Study Area Activity

Table 4.17-13 summarizes projected annual federal, state and local tax revenues resulting from uranium production in the North Study Area under Alternative B. Under Alternative B, total government revenues are projected to be approximately $5.9 million per year. Annual state government revenues are projected at $1.6 million, and state revenues from income and sales-related taxes would be divided between the State of Arizona and the State of Utah. Local government revenues are projected at about $1.5 million per year. These estimates indicate that Alternative B would decrease government revenues related to uranium production by about 70% relative to Alternative A.

Relative to the overall scale of the federal government, however, a decrease in revenues of $6.1 million per year would be considered a minor effect. The same holds true for the reduction in state government revenues that could be collected under Alternative B.

At the local level, the decrease of $3.5 million per year in government revenues (relative to Alternative A) that could occur under Alternative B would likely represent a minor effect for most of the North Study Area, but could have a moderate effect on the most directly affected communities. At least some portion of the reduced local revenues could be partly offset by lower costs to provide government services to new residents and businesses.

Table 4.17-13. Projected Annual Government Revenues from Alternative B Uranium Production in the North Study Area (in millions of 2010 dollars)

Revenue Types and Recipients		Difference from Alternative A
Federal Tax Revenues		
Social Insurance Programs	$1.1	−$2.3
Income and Profits Taxes	$1.3	−$2.8
Indirect Business Taxes	$0.4	−$1.0
Subtotal	*$2.8*	*−$6.1*
State Tax Revenues		
Severance Taxes	$0.3	−$0.6
Income Taxes	$0.4	−$0.8
Sales-Related Taxes	$0.9	−$2.1
Subtotal	*$1.6*	*−$3.5*
Local Government Revenues		
Sales-Related Taxes	$0.5	−$1.1
Property Taxes	$1.0	−$2.4
Subtotal	*$1.5*	*−$3.5*
Total Government Revenues	**$5.9**	**−$13.1**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

SOUTH STUDY AREA

Federal Revenues

Under Alternative B, the projected annual total output of about $3 million per year directly and indirectly related to uranium mining in the South Study Area would produce an estimated $170,000 per year in revenues for the federal government.

State Revenues

The annual uranium mining-related regional output in the South Study Area under Alternative B would produce an estimated $90,000 per year in revenues for the State of Arizona.

Local Government Revenues

Local governments in the South Study Area would receive a projected total of $40,000 per year in sales-related taxes and $70,000 per year in property tax revenues related to uranium mining under Alternative B.

Summary and Assessment of Taxes and Revenues under Alternative B from North Study Area Activity

Table 4.17-14 summarizes projected annual federal, state and local tax revenues resulting from uranium mining in the South Study Area under Alternative B. Total combined revenues to all government entities from uranium mining in the South Study Area are projected at approximately $370,000 per year, about $3.5 million less than under Alternative A. This reduction would likely represent a minor effect.

Table 4.17-14. Projected Annual Government Revenues from Alternative B Uranium Mining in the South Study Area (in millions of 2010 dollars)

Revenue Types and Recipients		Difference from Alternative A
Federal Tax Revenues		
Social Insurance Programs	$0.07	−$0.63
Income and Profits Taxes	$0.08	−$0.72
Indirect Business Taxes	$0.02	−$0.18
Subtotal	*$0.17*	*−$1.53*
State Tax Revenues		
Severance Taxes	$0.02	−$0.19
Income Taxes	$0.02	−$0.18
Sales-Related Taxes	$0.05	−$0.55
Subtotal	*$0.09*	*−$0.92*
Local Government Revenues		
Sales-Related Taxes	$0.04	−$0.46
Property Taxes	$0.07	−$0.63
Subtotal	*$0.11*	*−$1.09*
Total Government Revenues	**$0.37**	**−$3.54**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

RECREATION AND ENVIRONMENTAL ECONOMICS

Nonconsumptive Recreation

Alternative B would include less road creation and less mining activity, compared with Alternative A. There is likely to be little or no overall impact to visitor use or change in the annual economic benefits of recreation under this alternative. Alternative B could provide a minor benefit in terms of nonconsumptive recreation relative to Alternative A.

Hunting

Under Alternative B, the total estimated ground disturbance is 164 acres over a 20-year period for all phases, or an average of 8 acres per year. Alternative B would result in a surface disturbance that, compared with the overall available hunting area for the four GMUs affected by the proposed withdrawal parcels, would be negligible. Section 4.7 (Fish and Wildlife) further concluded that effects to the quality and quantity of unfragmented habitat would not be measurable or apparent under Alternative B. As a result, mining activity under Alternative B would be expected to result in no impact to the estimated annual benefit of hunting recreation. Since Alternative A would also be expected to result in no noticeable impact to hunting, there would be essentially no difference between the alternatives in this regard.

Economic Aspects of Environmental Quality at Grand Canyon National Park

Compared with Alternative A, Alternative B would result in fewer fugitive dust emissions and therefore less impact to air quality (see Section 4.2). The recreation setting within the proposed withdrawal areas, and the corresponding recreation benefits provided by those areas, would be affected less under Alternative B than under any of the other alternatives.

As discussed under Alternative A, there is insufficient information available to estimate any effects on the existence value of Grand Canyon National Park or effects on the economic value of the ecological services that the Park provides.

ENERGY RESOURCES

Under Alternative B, 10,658 tons (21 million pounds) of uranium are projected to be produced from the proposed withdrawal areas over the 20 year period, reflecting an annual average of just over 1 million pounds of production. Current U.S. production (4.2 million pounds in 2010) meets 9% of domestic demand. Thus, the additional production from the withdrawal under Alternative B could meet about 2% of current U.S. demand and increase total domestic production to the equivalent of 11% of annual U.S. demand. Projected annual uranium production under Alternative B could increase global production of uranium by about 1%.

Based on the projections developed for the RFD, Alternative B would have a major effect on U.S. uranium production relative to Alternative A. Alternative B would have a moderate long-term effect on overall U.S. energy resources relative to Alternative A.

ROAD CONDITION AND MAINTENANCE

Under Alternative B, 6.4 miles of new roads are projected to be constructed. An estimated 106,225 haul trips would occur on area roads over the 20-year time frame (see Appendix B), or an average of about 5,311 haul trips per year (about 17 trips per day assuming a six day per week schedule) under this alternative. An estimated 93% of the haul trips (98,978) would originate from the proposed north withdrawal area and 7% (7,247) from the proposed south withdrawal area. No mines or haul trips are anticipated in the proposed east withdrawal area under Alternative B.

Most of the new roads would be constructed within the North Parcel (on BLM land). The addition of 6.4 miles of new roads would represent an increase of less than 1% of the BLM transportation system of primary, secondary, and tertiary unpaved roads. The projected 6.4 miles of new roads would be less than one-third of the new road construction anticipated under Alternative A (22.4 miles).

As under each of the alternatives, mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore. Consequently, no effects on public costs to maintain unpaved roads are expected.

In general, the addition of approximately 17 haul trips per day on county and state roads and U.S. highways is not expected to have a significant effect on maintenance requirements or costs, given the volume of traffic that already occurs on these roads. The largest projected impact on traffic volumes (in percentage terms) would be expected to occur on U.S. 89A, 191, and 160 in Arizona, and U.S. 191 in Utah, where haul trips could increase average daily traffic volumes by up to 0.93% to 1.59%.

In Section 4.16, an average of about 0.5 rollover accidents and spills per year was projected under Alternative B. As noted earlier for Alternative A, based on a 2005 study in Washington, there could both immediate cleanup costs and post mining final cleanup costs associated with such spills, but these costs would be expected to be paid for by the mining and/or hauling companies.

Overall, under Alternative B, would be at most a minor benefit in terms of road maintenance costs funded by public entities relative to Alternative A.

Cumulative Impacts

As under Alternative A, cumulative impacts under Alternative B are anticipated to be essentially the same as the direct and indirect impacts discussed previously. The direct and indirect economic effects of Alternative B, as described in the preceding pages, are expressed in terms of the incremental effects of the alternative on the economic conditions in the study area. Other changes in the population and economy of the study area over the 20 year proposed withdrawal period, such as ongoing economic and population growth in some communities, would not substantially alter these incremental effects.

4.17.5 Impacts of Alternative C: Partial Withdrawal (~650,000 Acres)

Under Alternative C, approximately 650,000 acres of federal lands within the proposed withdrawal areas would be withdrawn from entry and location of new mining claims. This withdrawal would encompass about 70% of the lands proposed for withdrawal under Alternative B (Full Withdrawal). As described in the RFD (see Appendix B), it is estimated that up to 14 new mines might be developed within the proposed withdrawal areas (based on the assumption that they have valid existing claims), combined with the four existing mines, for a cumulative total of 18 mines in operation over the 20 year period. It is estimated that the existing and new mines could produce up to 42 million pounds of uranium over the 20 year period (see Appendix B). Based on the assumed price of $40 per pound, the cumulative value of production over the 20 year period (including value added through hauling and milling) would be approximately $1.7 billion (in 2010 dollars).

Regional Economic Effects under Alternative C

NORTH STUDY AREA

Approximately 32.6 million pounds of the projected cumulative production of uranium under Alternative C (77% of the total) would be anticipated to be mined from the proposed north withdrawal parcel and the proposed east withdrawal parcel, both located in the North Study Area (see Appendix B). Average annual production within the North Study Area over the 20 year period would be about 1.63 million pounds. Excluding the 15% of the value estimated to be added during the milling process, at a price of $40 per pound the average annual output from uranium mining in the North Study Area would be about $55 million (2010 dollars).

All uranium mined from both the North Study Area and the South Study Area is anticipated to be milled at the White Mesa Mill, located in the North Study Area. Including the projected annual uranium production of 0.49 million pounds from the South Study Area (proposed south withdrawal parcel), the average annual value added from milling under Alternative C is projected to be about $13 million (2010 dollars).

Projected Average Annual Economic Effects

Combining the annual value from mining and milling, uranium production under Alternative C is projected to directly produce approximately $68 million per year in regional economic output in the North Study Area. This projected annual economic output from the mining sector was incorporated into the IMPLAN model developed for the North Study Area to estimate direct and indirect effects on value-added, employment and earnings.

Table 4.17-15 depicts the projected, average annual overall effects of uranium mining on the economy of the North Study Area under Alternative C. Uranium production activities in the North Study Area are projected to provide about 127 direct jobs per year and about $9.6 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining and milling activities are projected to support about 277 total jobs and labor compensation of approximately $15.7 million in the North Study Area under Alternative C.

Table 4.17-15. Overall Average Annual Effects from Uranium Mining in North Study Area (Alternative C)

	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Annual Economic Effects				
Direct Effect	$68.0	127	$9.6	$47.4
Indirect Effect	$19.6	64	$3.6	$12.2
Induced Effect	$7.9	86	$2.5	$4.7
Total Effect	**$95.5**	**277**	**$15.7**	**$64.2**
Effects Relative to Alternative A				
Direct Effect	−$58.0	−108	−$8.2	−$40.4
Indirect Effect	−$16.7	−55	−$3.0	−$10.4
Induced Effect	−$6.7	−73	−$2.2	−$4.0
Total Effect	**−$81.4**	**−236**	**−$13.4**	**−$54.8**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Total Job Distribution by Sector

The annual total jobs in the North Study Area projected to be supported by uranium mining under Alternative C are broken down by sector in Table 4.17-16. The largest number of total jobs would be in mining (which includes uranium milling under the North American Industry Classification System). The other sectors projected to experience the largest employment effects include health and social services; retail trade; and finance and insurance.

Relative to Alternative A, Alternative C is projected to result in about 130 fewer jobs in the mining sector. There are also projected to be at least 10 fewer jobs in each of the following sectors: retail trade, finance and insurance, health and social services and accommodation and food services.

Table 4.17-16. Distribution of North Study Area Total Employment Effect by Sector (Alternative C)

NAICS Sector		Total Jobs*	Difference from Alternative A
11	Agriculture, Forestry, Fishing, and Hunting	1	−1
21	Mining	152	−130
22	Utilities	4	−3
23	Construction	2	−2
31–33	Manufacturing	2	−1
42	Wholesale Trade	5	−5
44–45	Retail Trade	17	−15
48–49	Transportation and Warehousing	8	−6
51	Information	2	−2
52	Finance and Insurance	12	−10
53	Real Estate and Rentals	10	−9
54	Professional, Scientific, and Technical Services	10	−9
55	Management of Companies	2	−2
56	Administrative and Waste Services	5	−4
61	Educational Services	2	−2
62	Health and Social Services	19	−16
71	Arts, Entertainment, and Recreation	3	−3
72	Accommodation and Food Services	11	−10
81	Other Services	8	−7
92	Government and non-NAICs	2	−2
Total		**277**	**−236**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

Assessment of Economic Effects of Mining in the North Study Area under Alternative C

The reduction of approximately 236 jobs (compared to Alternative A) would represent about three-tenths of one percent decrease in the total number of jobs in the study area. Relative to the overall size of the North Study Area economy, the lower level of uranium mining under Alternative C would decrease North Study Area value added (gross regional product) by about 1.4%. The projected regional economic effects in the North Study Area from uranium production under Alternative C are a little more than half of the projected effects under Alternative A and about 74% larger than projected economic effects under

Alternative B. From the standpoint of the North Study Area as a whole, this would likely represent a minor economic effect over the 20 year withdrawal period.

It is likely that much of the direct economic effect would be concentrated in or near the communities most proximate to the proposed north withdrawal parcel (Fredonia, Kanab, the Kaibab Paiute Tribe, and Colorado City), and in Blanding where the uranium is projected to be processed. The reduction in uranium production under Alternative C would represent a minor to moderate effect on future economic conditions in these areas during the 20 year withdrawal period.

Effects of Alternative Future Prices and Price Variability

If future prices are, on average, considerably higher than the $40 per pound assumed in the RFD, the pace of allowable mining activity under Alternative C might accelerate. During the first part of the 20 year study period, the annual economic benefits from mining might be greater than estimated in this analysis. The faster pace would, however, also accelerate the exhaustion of economically recoverable uranium resources in the areas where new mining would be allowed to occur under Alternative C, leading to the end of mining activity (and the loss of mining-related jobs) prior to the end of the study period.

Uranium prices have historically been highly variable. It is likely that regardless of the future average price of uranium, there will be considerable fluctuation and periods of relatively high and relative low prices. The effects of corresponding “boom” and “bust” periods of uranium-related activity would have more impact on the stability of the most affected communities in the North Study Area than under Alternative B, but less impact than under Alternative A.

Effects on Regional Tourism Economy

Based upon the recreation resource evaluation (see Section 4.15), Alternative C would be expected to provide a minor benefit in terms of visitor use in and near the proposed withdrawal areas relative to Alternative A. Alternative C would be expected to provide a corresponding, minor benefit for the tourism-related economy in the North Study Area relative to Alternative A.

SOUTH STUDY AREA

Approximately 9.8 million pounds of the projected cumulative production of uranium under Alternative C (23% of the total) would be anticipated to be mined from the proposed south withdrawal parcel, located in the South Study Area. Average annual production within the South Study Area over the 20 year period would be about 0.49 million pounds. Excluding the 15% of the value estimated to be added during the milling process (which would accrue to the North Study Area), at a price of $40 per pound the average annual output from uranium mining in the South Study Area would be about $17 million (2010 dollars).

Projected Average Annual Economic Effects

The projected $17 million in average annual economic output from the mining sector was incorporated into the IMPLAN model developed for the South Study Area to estimate direct and indirect effects on value-added, employment and earnings.

Table 4.17-17 depicts the projected, average annual overall effects of uranium mining on the economy of the South Study Area under Alternative C. Uranium mining operations in the South Study Area are projected to directly provide an average of 32 direct jobs per year and about $1.8 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining activities are projected to support about 66 total jobs and labor compensation of approximately $3.3

million in the South Study Area under Alternative C. These figures are about 47% lower than under Alternative A.

Table 4.17-17. Overall Average Annual Effects from Uranium Mining in South Study Area (Alternative C)

	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Annual Economic Effects				
Direct Effect	$17.0	32	$1.8	$8.9
Indirect Effect	$4.3	17	$0.9	$2.4
Induced Effect	$1.8	17	$0.6	$1.1
Total Effect	**$23.1**	**66**	**$3.3**	**$12.4**
Effects Relative to Alternative A				
Direct Effect	−$15.0	−28	−$1.6	−$7.8
Indirect Effect	−$3.8	−15	−$0.8	−$2.1
Induced Effect	−$1.6	−15	−$0.5	−$0.9
Total Effect	**−$20.4**	**−58**	**−$2.9**	**−$10.9**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Total Job Distribution by Sector

The annual total jobs in the South Study Area projected to be supported by uranium mining under Alternative C are broken down by sector in Table 4.17-18. The largest number of total jobs would be in mining. The other sectors projected to experience the largest employment effects include health and social services; retail trade; and professional, scientific and technical services.

Table 4.17-18. Distribution of South Study Area Total Employment Effect by Sector (Alternative C)

NAICS Sector		Total Jobs*	Difference from Alternative A
11	Agriculture, Forestry, Fishing, and Hunting	1	0
21	Mining	37	−33
22	Utilities	1	−1
23	Construction	0	0
31–33	Manufacturing	1	−1
42	Wholesale Trade	1	−1
44–45	Retail Trade	4	−3
48–49	Transportation and Warehousing	2	−2
51	Information	0	0
52	Finance and Insurance	2	−1
53	Real Estate and Rentals	1	−1
54	Professional, Scientific, and Technical Services	3	−3
55	Management of Companies	1	−1
56	Administrative and Waste Services	1	−1

Table 4.17-18. Distribution of South Study Area Total Employment Effect by Sector (Alternative C), Continued

NAICS Sector		Total Jobs*	Difference from Alternative A
61	Educational Services	0	0
62	Health and Social Services	4	−4
71	Arts, Entertainment, and Recreation	1	−1
72	Accommodation and Food Services	2	−2
81	Other Services	2	−2
92	Government and non-NAICs	1	−1
Total		**66**	**−58**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

Assessment of Economic Effects of Mining in the South Study Area under Alternative C

From the standpoint of the South Study Area as a whole (and even the communities potentially most affected within the South Study Area), the reduction in economic activity stimulated by uranium mining under Alternative C (compared to Alternative A) would likely be unnoticeable. The difference of 58 jobs would correspond to about 0.04% of the total number of jobs that currently exist in the South Study Area.

Effects of Alternative Future Prices and Price Variability

Alternative price scenarios or future variation in the price of uranium could accelerate or slow projected uranium development in the South Study Area under Alternative C. Relative to the potential effects of price variability on the North Study Area, such effects would have minor economic ramifications in the South Study Area.

Effects on Regional Tourism Economy

Based upon the recreation resource evaluation (see Section 4.15), Alternative C is expected to have minor effects on visitor use in and near the proposed withdrawal areas. There would likely to be little or no effect on the tourism-related economy in the South Study Area relative to Alternative A.

Effects on Taxes and Revenues under Alternative C

The projected uranium mining activity under Alternative C would produce additional revenues for the federal government, for the State of Arizona and the State of Utah, and for local governments in the study area.

NORTH STUDY AREA

Federal Revenues

Under Alternative C, the projected total annual output of about $96 million per year resulting from uranium mining and processing in the North Study Area would produce an estimated average of $4.9 million per year in revenues for the federal government. This total includes a projected $1.9 million per year in contributions to social insurance programs (social security and Medicare), an estimated $2.2 million per year in personal income and corporate profit taxes and approximately $0.8 million per year in indirect, federal business taxes.

State Revenues

Annual uranium production in the North Study Area would produce an estimated $0.7 million in state income tax revenues and a projected $1.6 million per year in state sales tax revenues. These $2.3 million in combined state revenues would be divided between the State of Arizona and the State of Utah, depending on where uranium miners (and the indirect workers supported by uranium production) live and work and the locations where taxable sales occur.

Net of value added during the milling process (which is not subject to severance taxes), the annual direct value added by uranium mining in the North Study Area under Alternative C is estimated at approximately $38 million. Applying the State of Arizona's 2.5% severance tax to 50% of this value added estimate results in a projected annual average of about $0.5 million per year in severance tax revenues.

Local Government Revenues

Local governments in the North Study Area would receive a projected total of $0.9 million per year in sales-related taxes and a projected total of $1.8 million per year in property tax revenues due to uranium mining under Alternative C.

Summary and Assessment of Taxes and Revenues under Alternative B from North Study Area Activity

Table 4.17-19 summarizes projected annual federal, state and local tax revenues resulting from uranium production in the North Study Area under Alternative C. Under Alternative C, total government revenues are projected to be approximately $10.4 million per year. Annual state government revenues are projected at $2.8 million, and state revenues from income and sales-related taxes would be divided between the State of Arizona and the State of Utah. Local government revenues are projected at about $2.7 million per year. All of these estimates reflect about a 48% decrease in the projected government revenue benefits compared to Alternative A but are about 75% greater than the projected government revenue benefits under Alternative B.

Relative to the overall scale of the federal government a decrease in revenues of $4.0 million per year (relative to Alternative A) would be considered a minor effect. The same holds true for the reduction in state government revenues that could be collected under Alternative C.

At the local level, the decrease of $2.3 million per year in government revenues that could occur under Alternative C would likely represent a minor effect for both the most directly affected communities and for county governments in the study area. At least some portion of the reduction in local revenues could be partly offset by reduced costs of providing government services to new residents and businesses (compared to Alternative A).

Table 4.17-19. Projected Annual Government Revenues from Alternative C Uranium Production in the North Study Area (in millions of 2010 dollars)

Revenue Types and Recipients		Difference from Alternative A
Federal Tax Revenues		
Social Insurance Programs	$1.9	-$1.5
Income and Profits Taxes	$2.2	-$1.9
Indirect Business Taxes	$0.8	-$0.6
Subtotal	*$4.9*	*-$4.0*

Table 4.17-19. Projected Annual Government Revenues from Alternative C Uranium Production in the North Study Area (in millions of 2010 dollars), Continued

Revenue Types and Recipients		Difference from Alternative A
State Tax Revenues		
Severance Taxes	$0.5	-$0.4
Income Taxes	$0.7	-$0.5
Sales-Related Taxes	$1.6	-$1.4
Subtotal	*$2.8*	*-$2.3*
Local Government Revenues		
Sales-Related Taxes	$0.9	-$0.7
Property Taxes	$1.8	-$1.6
Subtotal	*$2.7*	*-$2.3*
Total Government Revenues	$10.4	-$8.6

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

SOUTH STUDY AREA

Federal Revenues

Under Alternative C, the projected annual total output of about $23 million per year directly and indirectly related to uranium mining in the South Study Area would produce an estimated $0.9 million per year in revenues for the federal government.

State Revenues

The annual mining-related regional output in the South Study Area under Alternative C would produce an estimated $0.5 million per year in new government revenues for the State of Arizona.

Local Government Revenues

Local governments in the South Study Area would receive a projected total of $0.6 million per year in sales-related taxes and property taxes related to mining under Alternative C.

Summary and Assessment of Taxes and Revenues under Alternative C from North Study Area Activity

Table 4.17-20 summarizes projected annual federal, state and local tax revenues resulting from uranium mining in the South Study Area under Alternative C. Total combined revenues to all government entities from uranium mining in the South Study Area are projected at approximately $2.0 million per year, a reduction of $1.9 million per year compared to Alternative A. This would be a minor fiscal effect.

Table 4.17-20. Projected Annual Government Revenues from Alternative C Uranium Mining in the South Study Area (in millions of 2010 dollars)

Revenue Types and Recipients		Difference from Alternative A
Federal Tax Revenues		
Social Insurance Programs	$0.4	-$0.3
Income and Profits Taxes	$0.4	-$0.4
Indirect Business Taxes	$0.1	-$0.1
Subtotal	$0.9	-$0.8
State Tax Revenues		
Severance Taxes	$0.1	-$0.1
Income Taxes	$0.1	-$0.1
Sales-Related Taxes	$0.3	-$0.3
Subtotal	$0.5	-$0.5
Local Government Revenues		
Sales-Related Taxes	$0.2	-$0.3
Property Taxes	$0.4	-$0.3
Subtotal	$0.6	-$0.6
Total Government Revenues	$2.0	-$1.9

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

RECREATION AND ENVIRONMENTAL ECONOMICS

Nonconsumptive Recreation

Alternative C would include less road creation and less mining activity, compared with Alternative A, but more of both than under Alternative B. The creation of 12.1 miles of temporary new roads for mining under Alternative C is expected to offset any potential impacts associated with impacts to recreationists resulting from mining activity (visual, soundscape, etc.). Little or no overall impact to visitor use or change in the annual economic benefits of recreation is anticipated under this alternative. Relative to Alternative A, this would represent a minor benefit in terms of the economic benefits of recreation under Alternative C.

Hunting

Under Alternative C, the total estimated ground disturbance is 532 acres over a 20-year period for all phases, or an average of 26 acres per year. Alternative C would result in a surface disturbance that, compared with the overall available hunting area for the four GMUs affected by the withdrawal parcels, would be negligible. As under Alternative B, Section 4.7 (Fish and Wildlife) concluded that effects to the quality and quantity of unfragmented habitat would not be measurable or apparent under Alternative C. As a result, mineral activity under Alternative C would likely result in no impact to the estimated annual benefit of hunting recreation. Since Alternative A would also be expected to result in no noticeable impact to hunting, there would be essentially no difference between the alternatives in this regard.

Economic Aspects of Environmental Quality at Grand Canyon National Park

Compared with Alternative A, Alternative C would result in fewer fugitive dust emissions and therefore less impact to air quality (see Section 4.2). Dust emissions would be greater under Alternative C than under Alternative B.

As discussed under Alternative A, there is insufficient information available to estimate any effects on the existence value of Grand Canyon National Park or effects on the economic value of the ecological services that the Park provides.

ENERGY RESOURCES

Under Alternative C, 21,158 tons (42 million pounds) of uranium are projected to be produced from the proposed withdrawal areas over the 20 year period, reflecting an annual average of about 2.1 million pounds of production. Current U.S. production (4.2 million pounds in 2010) meets 9% of domestic demand. Thus, the additional production from the withdrawal under Alternative C could meet about 4% of current U.S. demand and increase total domestic production to the equivalent of 13% of annual U.S. demand. Projected annual uranium production under Alternative C could increase global production of uranium by about 2%.

Based on the projections developed for the RFD, Alternative C would have a moderate long-term effect on U.S. uranium production relative to Alternative A. Alternative C would have a minor long-term effect on overall U.S. energy resources relative to Alternative A.

ROAD CONDITION AND MAINTENANCE

Under Alternative C, 12.1 miles of new roads are projected to be constructed. An estimated 184,065 haul trips would occur on area roads over the 20-year time frame (see RFD, Appendix B), or an average of about 9,203 haul trips per year (about 29 trips per day under a six day per week schedule) under this alternative. An estimated 72% of the haul trips (132,338) would originate from the proposed north withdrawal area, 6% of the trips (11,120) would originate from the proposed east withdrawal area, and 22% (40,607) from the proposed south withdrawal area.

The projected 12.1 miles of new roads would be a little more than one-half of the new road construction anticipated under Alternative A (22.4 miles) and almost twice as much road construction as anticipated under Alternative B (6.4 miles). Eighty-five percent of the new roads (10.3 miles) would be constructed within the proposed north and east withdrawal areas (on BLM land). The addition of 10.3 miles of new roads would represent an increase of less than 1% of the BLM transportation system of primary, secondary, and tertiary unpaved roads. The additional 1.8 miles of projected new roads on Forest Service lands in the proposed south withdrawal area would also represent less than 1% of existing unpaved roads in that area.

As under each of the alternatives, mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore. Consequently, no effects on public costs to maintain unpaved roads are expected.

In general, the addition of approximately 29 haul trips per day on county and state roads and U.S. highways is not expected to have a significant effect on maintenance requirements or costs, given the volume of traffic that already occurs on these roads. Like the other alternatives, under Alternative C the largest percentage increase in traffic volume is projected to occur on U.S. 89A, 191, and 160 in Arizona, and U.S. 191 in Utah, where haul trips could increase average daily traffic volumes by up to 1.25% to 2%.

In Section 4.16, an average of about 0.8 rollover accidents and spills per year was projected under Alternative C. As noted earlier for Alternative A, based on a 2005 study in Washington, there could both immediate cleanup costs and post mining final cleanup costs associated with such spills, but these costs would be expected to be paid for by the mining and/or hauling companies.

Overall, under Alternative C, there is no anticipated impact to road maintenance costs funded by public entities relative to Alternative A

Cumulative Impacts

As under Alternative A and Alternative B, cumulative impacts under Alternative C are anticipated to be essentially the same as the direct and indirect impacts discussed previously. The direct and indirect economic effects of Alternative C, as described in the preceding pages, are expressed in terms of the incremental effects of the alternative on the economic conditions in the study area. Other changes in the population and economy of the study area over the 20 year proposed withdrawal period, such as ongoing economic and population growth in some communities, would not substantially alter these incremental effects.

4.17.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 300,000 acres of federal lands within the proposed withdrawal areas would be withdrawn from entry and location of new mining claims. This withdrawal would encompass about 30% of the lands proposed for withdrawal under Alternative B (Full Withdrawal). As described in the RFD (see Appendix B), it is estimated that up to 22 new mines might be developed within the proposed withdrawal areas (based on the assumption that they have valid existing claims), combined with the four existing mines, for a cumulative total of 26 mines in operation over the 20 year period. It is estimated that the existing and new mines could produce approximately 66 million pounds of uranium over the 20 year period (see Appendix B). Based on the assumed price of $40 per pound, the cumulative value of production over the 20 year period (including value added through hauling and milling) would be approximately $2.6 billion (in 2010 dollars).

Regional Economic Effects under Alternative D

NORTH STUDY AREA

Approximately 53.2 million pounds of the projected cumulative production of uranium under Alternative D (80% of the total) would be anticipated to be mined from the proposed north withdrawal parcel and the proposed east withdrawal parcel, both located in the North Study Area (see Appendix B). Average annual production within the North Study Area over the 20 year period would be about 2.66 million pounds. Excluding the 15% of the value estimated to be added during the milling process, at a price of $40 per pound the average annual output from uranium mining in the North Study Area would be about $90 million (2010 dollars).

All uranium mined from both the North Study Area and the South Study Area is anticipated to be milled at the White Mesa Mill, located in the North Study Area. Including the projected annual uranium production of 0.65 million pounds from the South Study Area (proposed south withdrawal parcel), the average annual value added from milling under Alternative D is projected to be about $20 million (2010 dollars).

Projected Average Annual Economic Effects

Combining the annual value from mining and milling, uranium production under Alternative D is projected to produce approximately $110 million per year in regional economic output in the North Study Area. This projected annual economic output from the mining sector was incorporated into the IMPLAN model developed for the North Study Area to estimate direct and indirect effects on value-added, employment and earnings.

Table 4.17-21 depicts the projected, average annual overall effects of uranium mining on the economy of the North Study Area under Alternative D. Uranium production activities in the North Study Area are projected to provide about 205 direct jobs per year and about $15.5 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining and milling activities are projected to support about 448 total jobs and labor compensation of approximately $25.3 million in the North Study Area under Alternative D. These annual mining-related economic metrics under Alternative D are about 13% lower than under Alternative A.

Table 4.17-21. Overall Average Annual Effects from Uranium Mining in North Study Area (Alternative D)

	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Annual Economic Effects				
Direct Effect	$110.0	205	$15.5	$76.6
Indirect Effect	$31.7	104	$5.8	$19.7
Induced Effect	$12.7	139	$4.1	$7.6
Total Effect	**$154.4**	**448**	**$25.3**	**$103.9**
Effects Relative to Alternative A				
Direct Effect	-$16.0	-30	-$2.3	-$11.1
Indirect Effect	-$4.6	-15	-$0.8	-$2.9
Induced Effect	-$1.9	-20	-$0.6	-$1.1
Total Effect	**-$22.5**	**-65**	**-$3.7**	**-$15.1**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Total Job Distribution by Sector

The annual total jobs in the North Study Area projected to be supported by uranium mining under Alternative D are broken down by sector in Table 4.17-22. The largest number of total jobs would be in mining (which includes uranium milling under the North American Industry Classification System). The other sectors projected to experience the largest employment effects include health and social services; retail trade; and finance and insurance. As in the analysis of the other withdrawal alternatives (Alternatives B and C), the largest reduction in jobs, compared to Alternative A, would be in the mining sector.

Table 4.17-22. Distribution of North Study Area Total Employment Effect by Sector (Alternative D)

NAICS Sector		Total Jobs*	Difference from Alternative A
11	Agriculture, Forestry, Fishing, and Hunting	2	0
21	Mining	246	-36
22	Utilities	7	-1
23	Construction	3	0
31–33	Manufacturing	3	0
42	Wholesale Trade	9	-1
44–45	Retail Trade	28	-4
48–49	Transportation and Warehousing	12	-2
51	Information	3	0
52	Finance and Insurance	19	-3
53	Real Estate and Rentals	17	-2
54	Professional, Scientific, and Technical Services	16	-2
55	Management of Companies	3	0
56	Administrative and Waste Services	8	-1
61	Educational Services	3	0
62	Health and Social Services	30	-4
71	Arts, Entertainment, and Recreation	5	-1
72	Accommodation and Food Services	18	-3
81	Other Services	13	-2
92	Government and non-NAICs	3	0
Total		**448**	**-65**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

Assessment of Economic Effects of Mining in the North Study Area under Alternative D

The reduction of approximately 65 jobs would affect the economy of the North Study Area, but relative to the overall size of the economy these effects would be small. Compared to Alternative A, uranium mining under Alternative D would decrease North Study Area value added (gross regional product) by less than four-tenths of one percent and would decrease employment by less than one-tenth of one percent. From the standpoint of the North Study Area as a whole, this would likely represent a minor economic effect and might not be discernible.

Relative to the overall size of the North Study Area economy, uranium mining under Alternative D would increase North Study Area value added (gross regional product) by about 2.6% and increase employment by about one-half of one percent. From the standpoint of the North Study Area as a whole, this would likely represent a moderate economic benefit.

It is likely that much of the direct economic effect would be concentrated in or near the communities most proximate to the proposed north withdrawal parcel (Fredonia, Kanab, the Kaibab Paiute Tribe, and Colorado City), and in Blanding where the uranium is projected to be processed. The reduction in Uranium production under Alternative D (compared to Alternative A) would likely have no more than a minor economic effect in these areas.

Effects of Alternative Future Prices and Price Variability

Under Alternative D, effects of alternative future uranium prices, and cyclical variability in uranium prices, would be similar to effects under Alternative A. If future prices are, on average, considerably higher than the $40 per pound assumed in the RFD, the pace of allowable mining activity under Alternative D might accelerate. During the first part of the 20 year study period, the annual economic benefits from mining might be greater than estimated in this analysis. The faster pace would, however, also accelerate the exhaustion of economically recoverable uranium resources in the areas where new mining would be allowed to occur under Alternative D, leading to the end of mining activity (and the loss of mining-related jobs) prior to the end of the study period.

The effects of "boom" and "bust" periods of uranium-related activity, related to variability in prices over the 20 year projection period, would have more impact on the stability of the most affected communities in the North Study Area than under Alternative B or Alternative C, but slightly less impact than under Alternative A.

Effects on Regional Tourism Economy

The recreation resource evaluation (see Section 4.15) notes that an important distinction between Alternative D and Alternative C. Alternative D would not withdraw lands in proximity to Toroweap Road from future claims and development. If mineral exploration and development is visible from Toroweap Road, it could affect recreation settings and opportunities.

As under Alternative A, some impacts to the visitor experience, and potentially to visitor use, could occur due to the presence of heavy haul trucks on access roads, noise and visual intrusion. Ultimately, any effect on tourist visits would depend largely on whether uranium exploration and development activities change the public perception of the experience of visiting the Grand Canyon. Based on the recreation resource evaluation, Alternative D is expected to provide minor benefits to the tourism-related economy in the North Study Area relative to Alternative A.

SOUTH STUDY AREA

Approximately 13 million pounds of the projected cumulative production of uranium under Alternative D (20% of the total) would be anticipated to be mined from the proposed south withdrawal parcel, located in the South Study Area. Average annual production within the South Study Area over the 20 year period would be about 0.65 million pounds. Excluding the 15% of the value estimated to be added during the milling process (which would accrue to the North Study Area), at a price of $40 per pound the average annual output from uranium mining in the South Study Area would be about $22 million (2010 dollars).

Projected Average Annual Economic Effects

The projected $22 million in average annual economic output from the mining sector was incorporated into the IMPLAN model developed for the South Study Area to estimate direct and indirect effects on value-added, employment and earnings.

Table 4.17-23 depicts the projected, average annual overall effects of uranium mining on the economy of the South Study Area under Alternative D. Uranium mining operations in the South Study Area are projected to directly provide an average of 41 direct jobs per year and about $2.3 million per year in labor compensation (including benefits). Including indirect and induced effects (multiplier effects), mining activities are projected to support about 85 total jobs and labor compensation of approximately $4.2 million in the South Study Area under Alternative D.

Table 4.17-23. Overall Average Annual Effects from Uranium Mining in South Study Area (Alternative D)

	Output (Million dollars)	Jobs	Labor Income (Million dollars)	Value Added (Million dollars)
Annual Economic Effects				
Direct Effect	$22.0	41	$2.3	$11.5
Indirect Effect	$5.6	22	$1.1	$3.1
Induced Effect	$2.3	22	$0.8	$1.4
Total Effect	**$29.9**	**85**	**$4.2**	**$16.0**
Effects Relative to Alternative A				
Direct Effect	-$10.0	-19	-$1.1	-$5.2
Indirect Effect	-$2.5	-10	-$0.5	-$1.4
Induced Effect	-$1.1	-10	-$0.4	-$0.6
Total Effect	**-$13.6**	**-39**	**-$1.9**	**-$7.3**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Total Job Distribution by Sector

The annual total jobs in the South Study Area projected to be supported by uranium mining under Alternative D are broken down by sector in Table 4.17-24. The largest number of total jobs would be in mining. The other sectors projected to experience the largest employment effects include health and social services; retail trade; and professional, scientific and technical services.

Table 4.17-24. Distribution of South Study Area Total Employment Effect by Sector (Alternative D)

NAICS Sector		Total Jobs*	Difference from Alternative A
11	Agriculture, Forestry, Fishing, and Hunting	1	0
21	Mining	48	-22
22	Utilities	1	-1
23	Construction	1	0
31–33	Manufacturing	1	0
42	Wholesale Trade	1	-1
44–45	Retail Trade	5	-2
48–49	Transportation and Warehousing	3	-1
51	Information	1	0
52	Finance and Insurance	2	-1
53	Real Estate and Rentals	1	-1
54	Professional, Scientific, and Technical Services	4	-2
55	Management of Companies	1	0
56	Administrative and Waste Services	2	-1
61	Educational Services	0	0
62	Health and Social Services	5	-2
71	Arts, Entertainment, and Recreation	1	0

Table 4.17-24. Distribution of South Study Area Total Employment Effect by Sector (Alternative D), Continued

NAICS Sector		Total Jobs*	Difference from Alternative A
72	Accommodation and Food Services	3	-1
81	Other Services	3	-1
92	Government and non-NAICs	1	0
Total		**85**	**-39**

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Number of jobs includes full-time and part-time jobs. Numbers may not add to total due to rounding.

Assessment of Economic Effects of Mining in the South Study Area under Alternative D

Alternative D is projected to result in 39 fewer mining-related jobs than Alternative A in the South Study Area. Relative to the overall size of the South Study Area economy, this reduction in uranium mining related economic activity would correspond to less than one-tenth of one percent of current gross regional product and an even smaller effect relative to the total number of jobs in the South Study Area. From the standpoint of the South Study Area as a whole (and even the communities potentially most affected within the South Study Area), these economic effects are likely be unnoticeable.

Effects of Alternative Future Prices and Price Variability

Alternative price scenarios or future variation in the price of uranium could accelerate or slow projected uranium development in the South Study Area under Alternative D. Relative to the potential effects of price variability on the North Study Area, such effects would have minor economic ramifications in the South Study Area.

Effects on Regional Tourism Economy

As under Alternative A, effects on visitation in and near the proposed withdrawal areas are expected to be minor as described in Section 4.15. Relative to Alternative A, there is expected to be no discernible difference in effects on the tourism-related economy in the South Study Area.

Effects on Taxes and Revenues under Alternative D

The projected uranium mining activity under Alternative D would produce revenues for the federal government, for the State of Arizona and the State of Utah, and for local governments in the study area.

NORTH STUDY AREA

Federal Revenues

Under Alternative D, the projected total annual output of about $154 million per year resulting from uranium mining and processing in the North Study Area would produce an estimated average of $7.8 million per year in revenues for the federal government. This total includes a projected $3.0 million per year in contributions to social insurance programs (social security and Medicare), an estimated $3.6 million per year in personal income and corporate profit taxes and approximately $1.2 million per year in indirect, federal business taxes.

State Revenues

Annual uranium production in the North Study Area would produce an estimated $1.1 million in state income tax revenues and a projected $2.7 million per year in state sales tax revenues. These $3.8 million in combined state revenues would be divided between the State of Arizona and the State of Utah, depending on where uranium miners (and the indirect workers supported by uranium production) live and work and the locations where taxable sales occur.

Net of value added during the milling process (which is not subject to severance taxes), the annual direct value added by uranium mining in the North Study Area under Alternative D is estimated at approximately $63 million. Applying the State of Arizona's 2.5% severance tax to 50% of this value added estimate results in a projected annual average of about $0.8 million per year in severance tax revenues.

Local Government Revenues

Local governments in the North Study Area would receive a projected total of $1.4 million per year in sales-related taxes under Alternative D and $3.0 million per year in property taxes related to uranium production.

Summary and Assessment of Taxes and Revenues under Alternative D from North Study Area Activity

Table 4.17-25 summarizes projected annual federal, state and local tax revenues resulting from uranium production in the North Study Area under Alternative D. Under Alternative D, total government revenues are projected to be approximately $16.8 million per year. Annual state government revenues are projected at $4.6 million, and state revenues from income and sales-related taxes would be divided between the State of Arizona and the State of Utah. Local government revenues are projected at about $4.4 million per year. All of these estimates are about 12% less than the projected government revenue benefits under Alternative A, but substantially greater than the projected government revenues under Alternative B or Alternative C.

Table 4.17-25. Projected Annual Government Revenues from Alternative D Uranium Production in the North Study Area (in millions of 2010 dollars)

Revenue Types and Recipients		Difference from Alternative A
Federal Tax Revenues		
Social Insurance Programs	$3.0	-$0.4
Income and Profits Taxes	$3.6	-$0.5
Indirect Business Taxes	$1.2	-$0.2
Subtotal	$7.8	-$1.1
State Tax Revenues		
Severance Taxes	$0.8	-$0.1
Income Taxes	$1.1	-$0.1
Sales-Related Taxes	$2.7	-$0.3
Subtotal	$4.6	-$0.5

Table 4.17-25. Projected Annual Government Revenues from Alternative D Uranium Production in the North Study Area (in millions of 2010 dollars), Continued

Revenue Types and Recipients		Difference from Alternative A
Local Government Revenues		
Sales-Related Taxes	$1.4	-$0.2
Property Taxes	$3.0	-$0.4
Subtotal	$4.4	-$0.6
Total Government Revenues	$16.8	-$2.2

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

Relative to the overall scale of the federal government, a decrease in revenues of $1.1 million per year relative to Alternative A would be considered a minor effect. The same holds true for the reduction in state government revenues that could be collected under Alternative D.

At the local level, reduction of $0.6 million per year in government revenues that could occur under Alternative D (compared to Alternative A) would likely represent a minor effect for the North Study Area as a whole, as well as a minor effect for the most directly affected communities in the study area. At least some portion of the reduction in local revenues could be partly offset by reduced costs of providing government services to new residents and businesses compared to Alternative A.

SOUTH STUDY AREA

Federal Revenues

Under Alternative D, the projected annual total output of about $30 million per year directly and indirectly related to uranium mining in the South Study Area would produce an estimated $1.2 million per year in new government revenues for the federal government.

State Revenues

The annual mining-related regional output in the South Study Area under Alternative D would produce an estimated $0.6 million per year in new government revenues for the State of Arizona.

Local Government Revenues

Local governments in the South Study Area would receive a projected total of $0.3 million per year in sales-related taxes and $0.5 million per year in mining-related property taxes under Alternative D.

Summary and Assessment of Taxes and Revenues under Alternative D from North Study Area Activity

Table 4.17-26 summarizes projected annual federal, state and local tax revenues resulting from uranium mining in the South Study Area under Alternative D. Total combined new revenues to all government entities from uranium mining in the South Study Area are projected at approximately $2.6 million per year, about $1.3 million less per year than under Alternative A. This would be a minor fiscal effect for each of these entities.

Table 4.17-26. Projected Annual Government Revenues from Alternative D Uranium Mining in the South Study Area (in millions of 2010 dollars)

Revenue Types and Recipients		Difference from Alternative A
Federal Tax Revenues		
Social Insurance Programs	$0.5	-$0.2
Income and Profits Taxes	$0.6	-$0.2
Indirect Business Taxes	$0.1	-$0.1
Subtotal	$1.2	-$0.5
State Tax Revenues		
Severance Taxes	$0.1	-$0.1
Income Taxes	$0.1	-$0.1
Sales-Related Taxes	$0.4	-$0.2
Subtotal	$0.6	-$0.4
Local Government Revenues		
Sales-Related Taxes	$0.3	-$0.2
Property Taxes	$0.5	-$0.2
Subtotal	$0.8	-$0.4
Total Government Revenues	$2.6	-$1.3

Source: BBC Research & Consulting using IMPLAN v3.0, 2011.

Note: Approximately 80% of Arizona severance tax collections are distributed back to local governments throughout the state. Dollar figures are in constant 2010 dollars. Numbers may not add to total due to rounding.

RECREATION AND ENVIRONMENTAL ECONOMICS

Impacts to nonconsumptive recreation, hunting, and existence and use value under Alternative D are expected to be very similar to Alternative A.

Nonconsumptive Recreation

Alternative D is projected to lead to the creation of about 19.1 miles of temporary, new roads for mining, about 15% less than the 22.4 miles of new roads projected under Alternative A. The creation of temporary new roads is expected to partly offset potential impacts associated with impacts to recreationists resulting from mining activity (visual, soundscape, etc.), though some impact to the recreational setting in the proposed withdrawal areas would be expected under Alternative D. Alternative D is likely to lead to no more than minor effects on the annual economic benefits of recreation relative to Alternative A.

Hunting

Under Alternative D, the total estimated ground disturbance is 951 acres over a 20-year period for all phases, or an average of 48 acres per year. Based on Section 4.7, impacts to wildlife would be similar to those identified under Alternative A. Effects on hunting activity and values under Alternative D are unlikely to be measurable.

Economic Aspects of Environmental Quality at Grand Canyon National Park

Compared with Alternative A, Alternative C would result in somewhat less fugitive dust emission and therefore less impact to air quality (see Section 4.2). Dust emissions would be greater under Alternative D than under Alternative B or Alternative C. As under the other alternatives, however, no measurable reduction in overall air quality or visibility is expected.

As discussed under Alternative A, there is insufficient information available to estimate any effects on the existence value of Grand Canyon National Park or effects on the economic value of the ecological services that the Park provides.

ENERGY RESOURCES

Under Alternative D, 33,158 tons (66 million pounds) of uranium are projected to be produced from the proposed withdrawal areas over the 20 year period, reflecting an annual average of about 3.3 million pounds of production. Current U.S. production (4.2 million pounds in 2010) meets 9% of domestic demand. Thus, the additional production from the withdrawal under Alternative D could meet about 7% of current U.S. demand and increase total domestic production to the equivalent of 16% of annual U.S. demand. Projected annual uranium production under Alternative D could increase global production of uranium by about 3%.

Based on the projections developed for the RFD, Alternative D would have a minor to moderate long-term effect on U.S. uranium production relative to Alternative A. Alternative D would have a minor long-term effect on overall U.S. energy resources relative to Alternative A.

ROAD CONDITION AND MAINTENANCE

Under Alternative D, 19.1 miles of new roads are projected to be constructed. An estimated 273,025 haul trips would occur on area roads over the 20-year time frame (see Appendix B), or an average of about 13,651 haul trips per year (about 44 trips per day, assuming a six day per week schedule) under this alternative. An estimated 77% of the haul trips (210,178) would originate from the proposed north withdrawal area, 4% of the trips (11,120) would originate from the proposed east withdrawal area, and 19% (51,727) from the proposed south withdrawal area.

The projected 19.1 miles of new roads under Alternative D is about 85% of the new road construction anticipated under Alternative A (22.4 miles), and more road construction than is anticipated under Alternative B or Alternative C. 87% of the new roads (16.7 miles) would be constructed within the proposed north and east withdrawal areas (on BLM land). The addition of 16.7 miles of new roads would represent an increase of less than 1% of the BLM transportation system of primary, secondary, and tertiary unpaved roads. The additional 2.4 miles of projected new roads on Forest Service lands in the proposed south withdrawal area would also represent less than 1% of existing unpaved roads in that area.

As under each of the alternatives, mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore. Consequently, no effects on public costs to maintain unpaved roads are expected.

In general, the addition of approximately 37 haul trips per day on county and state roads and U.S. highways is not expected to have a significant effect on maintenance requirements or costs, given the volume of traffic that already occurs on these roads. Like the other alternatives, under Alternative D the largest percentage increase in traffic volume is projected to occur on U.S. 89A, 191, and 160 in Arizona, and U.S. 191 in Utah, where haul trips could increase average daily traffic volumes by up to 1.98% to 3.37%. As under Alternative A, additional truck traffic on Arizona SR 98, would be a concern. The road is a light duty road, with minimal or no shoulders in places and is not well suited to heavy truck traffic. Coconino County is concerned that it will need to be upgraded if it is widely used for ore hauling (personal communication, Carl Taylor and Bill Towler, Coconino County 2011).

In Section 4.16, an average of about 1.2 rollover accidents and spills per year was projected under Alternative D. As noted earlier for Alternative A, based on a 2005 study in Washington, there could both immediate cleanup costs and post mining final cleanup costs associated with such spills, but these costs would be expected to be paid for by the mining and/or hauling companies.

Overall, under Alternative D, there would be no projected effect on road maintenance costs funded by public entities relative to Alternative A.

Cumulative Impacts

As under the other alternatives, cumulative impacts under Alternative D are anticipated to be essentially the same as the direct and indirect impacts discussed previously. The direct and indirect economic effects of Alternative D, as described in the preceding pages, are expressed in terms of the incremental effects of the alternative on the economic conditions in the study area. Other changes in the population and economy of the study area over the 20 year proposed withdrawal period, such as ongoing economic and population growth in some communities, would not substantially alter these incremental effects.

Chapter 5

CONSULTATION AND COORDINATION

This EIS has been prepared with input from and coordination with interested tribal governments, agencies, organizations, and individuals. The CEQ regulations [40 CFR 1500–1508] require an early scoping process to determine the issues related to the Proposed Action and alternatives that the EIS should address. The purpose of the scoping process is to identify important issues, concerns, and potential impacts that require analysis in the EIS and to eliminate insignificant issues and alternatives from detailed analysis. Public involvement is a vital component of NEPA for vesting the public in the decision-making process and allowing for full environmental disclosure.

5.1 PUBLIC INVOLVEMENT – SCOPING

The purpose of scoping is to provide an opportunity for members of the public to learn about the proposed withdrawal and to share any concerns or comments they may have. Input from the public scoping process is used to help the BLM identify issues and concerns to be considered in the EIS, as well as to identify potential alternatives. In addition, the scoping process helps to identify any issues that are not considered relevant and that can therefore be eliminated from detailed analysis in the EIS. The list of stakeholders and other interested parties is also updated and generally expanded during the scoping process.

The BLM hosted two scoping meetings in Fredonia and Flagstaff, Arizona, on September 30 and October 15, 2009, to provide the public with an opportunity to learn about the project and provide comments. The meeting in Fredonia was held at the Fredonia Elementary School on East Hortt, and the meeting in Flagstaff was held at the High Country Conference Center on Butler Avenue. An open house format was used to encourage two-way dialogue and to encourage discussions about issues to be addressed in the Northern Arizona Proposed Withdrawal EIS, concerns about the process, and development of the range of alternatives to be analyzed in the Draft EIS. Meeting attendees signed in upon entering, at which time they were provided with handouts and informed about the meeting format and how to comment at the meeting. The handouts and displays provided information about the NEPA process, project background, tentative project schedule, preliminary issues to be analyzed in the EIS, location maps, and how to provide comments. A 30-day scoping comment period was provided in order for the public to submit written comments related to potential issues.

The scoping meetings were advertised 15 days prior to their scheduled dates in the *Federal Register*, the *Southern Utah News,* and the *Arizona Daily Sun,* in an email to the BLM stakeholder mailing list, and on the BLM website at <http://www.blm.gov/az>. The BLM has maintained a link on the website for the Northern Arizona Proposed Withdrawal EIS to provide information to the public regarding the NEPA process, EIS schedule, public scoping, and other information pertinent to the project.

Members of the public were afforded several methods for providing comments during the scoping period. These included multiple comment stations with comment forms at the scoping meeting and the opportunity to send emails or letters to BLM personnel. A total of 83,525 comment submittals were received, with 1,805 of those identified as duplicate submittals.

5.1.1 Newsletters

The BLM has arranged to produce and publish several newsletters on the website <http://www.blm.gov/az> at important milestones during the course of the project. The first newsletter, published in March 2010, announced the publication of the scoping report and USGS report; it also provided a brief summary of the scoping report and project schedule and a technical discussion of what breccia pipes are and how they are mined. The second newsletter, published in February 2011, announced the public availability of the Draft EIS and included information on the alternative development process, maps illustrating the alternatives, and a narrative discussion of each alternative. Other newsletters will coincide with release of the Final EIS and with release of the ROD.

5.1.2 Mailing List

A mailing list identifying individuals (as points of contact) in organizations, agencies, and interest groups was used to provide information about the public meetings, scoping period deadlines, and other key milestones. The BLM mailing list was used as the foundation but was periodically revised, updated, and expanded throughout the scoping period and was further updated throughout the entire NEPA process. Individuals who signed in at either of the public meetings or submitted comments during the scoping period were automatically added to the mailing list unless they stated that they did not want to be added or did not want to receive additional information as the project progressed.

The first direct mailing related to the EIS process occurred on September 10, 2009, included 265 recipients (71 federal, state, and local government entities; 18 non-government organizations; 14 businesses; 25 tribal entities; and 137 media organizations). The mailing provided information about the Proposed Action, announced scoping meetings and locations, and provided information about how to submit comments. A second mailing was sent prior to announcing publication of the Draft EIS. This mailing included a summary of the Draft EIS and the alternatives that were analyzed, along with information about the comment period, how to review the EIS and how to comment, and the dates, times, and locations of all public review meetings. A third mailing at a future date will announce availability of the Final EIS, and a fourth mailing will announce availability of the ROD.

5.2 COOPERATING AGENCY CONSULTATION

The Council on Environmental Quality (CEQ) regulations [40 CFR 1508.5] define a cooperating agency as any federal agency (other than the lead agency) and any state or local agency or Indian tribe with jurisdictional authority or special expertise with respect to any environmental impact involved in a proposal. Because of the size of the proposed withdrawal area and the resources potentially affected by the proposed withdrawal or alternatives, 16 agencies (federal, state, tribal, and county) with jurisdictional authority and/or applicable special expertise cooperated in the development of this EIS.

The cooperating agencies that assisted in preparation of the EIS are listed and described in Section 1.4.2 and below in Table 5.2.1. They assisted with EIS preparation in a number of ways, including conducting or providing studies and inventories, reviewing baseline condition reports, identifying issues, assisting with the formulation of alternatives, and reviewing Preliminary Draft EIS text and other EIS materials. Not all of the cooperating agencies participated in all aspects of the EIS preparation. As lead agency, BLM is responsible for the content of the EIS.

The BLM held five meetings with the cooperating agencies. The meeting dates, locations, and general purpose are listed in Table 5.2.2.

Table 5.2-1. Cooperating Agencies

Cooperating Agency	
U.S. Forest Service; Kaibab National Forest	Hualapai Tribe
National Park Service; Grand Canyon National Park	Kaibab Band of Paiute Indians

Table 5.2-1. Cooperating Agencies (Continued)

Cooperating Agency	
U.S. Fish and Wildlife Service	Coconino County, Arizona
U.S. Geological Survey	Mohave County, Arizona
Arizona Game and Fish Department	Garfield County, Utah
Arizona Geological Survey	Kane County, Utah
Arizona Department of Mines and Mineral Resources	San Juan County, Utah
Arizona State Land Department	Washington County, Utah

Table 5.2-2. Cooperating Agency Meeting Dates and Description

Date	Location	General Purpose
December 1, 2009	Flagstaff, AZ	Provide orientation of the process and discuss roles and responsibilities of various agencies.
January 20, 2010	Kanab, UT	Review and discuss preliminary and draft alternatives.
February 23, 2010	Flagstaff, AZ	Review and discuss preliminary and draft alternatives.
May 5, 2010	Kanab, UT	Review and discuss preliminary and draft alternatives.
August 18, 2011	Kanab, UT	Review draft comment response to cooperating agency comments on the DEIS and the revised economic analysis.

5.3 COORDINATION WITH LOCAL GOVERNMENTS

The BLM coordinated with local governments by attending meetings conducted by local government organizations and by maintaining open channels of communications between the Arizona Strip District Manager and elected county officials. Although in itself not a Cooperating Agency, the AZ/UT Coalition of Coordinating Counties is made up entirely of county governments, including Washington, Kane, San Juan and Garfield Counties in Utah, and Mohave County in Arizona. This coalition has held three meetings or hearings with the BLM, Forest Service, industry representatives and others in attendance to discuss the withdrawal and to coordinate comments on the EIS and to the Secretary of Interior. Those meeting/hearing dates were: March 21, 2011 meeting in St. George, Utah; April 18, 2011 meeting in Fredonia, Arizona; and September 7, 2011 hearing in St. George, Utah.

5.4 CONSULTATION WITH TRIBAL GOVERNMENTS

Federal agencies are required to consult with American Indian tribes as part of the Advisory Council on Historic Preservation Regulations, Protection of Historic Properties [36 CFR 800], implementing Section 106 of the NHPA. Accordingly, NHPA outlines when federal agencies must consult with tribes and the issues and other factors this consultation must address. In addition, pursuant to EO 13175, executive departments and agencies are charged with engaging in regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications and are responsible for strengthening the government-to-government relationship between the United States and Indian tribes.

In August 2009, BLM and the Forest Service initiated consultation via letter with the following tribal governments: Chemehuevi Tribe, Colorado River Indian Tribes, Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Las Vegas Paiute Tribe, Moapa Band of Paiute Indians, Pahrump Band of Paiutes, Paiute Indian Tribe of Utah, Pueblo of Zuni, San Juan Southern Paiute Tribe, Navajo Nation, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe.

The Havasupai Tribe, Hopi Tribe, and Hualapai Tribe, Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah, Pueblo of Zuni, and Navajo Nation all requested active consultation. The BLM and Forest Service have had one or more project-related meetings with each of these tribes. A summary of the dates of and tribal entity(ies) attending these meetings is provided in Table 5.3-1. Tribes were provided with a copy of the DEIS and will be provided with a copy of this Final EIS, and consultation and partnering will continue throughout implementation of the selected action alternative, as required.

Table 5.4-1. Tribal Meeting Summary

Date	Attendees
November 2, 2009	Southern Paiute Tribal Chair Association*
November 2, 2009	Paiute Indian Tribe of Utah Tribal Council
November 3, 2009	Kaibab Band of Paiute Indians Tribal Council and Staff
November 19, 2009	Hopi Cultural Resources Advisory Task Team/Hopi Cultural Preservation Office
November 23, 2009	Hualapai Tribal Council
December 4, 2009	Navajo Historic Preservation Department
December 17, 2009	Paiute Indian Tribe of Utah Tribal Council
February 9, 2010	Pueblo of Zuni Tribal Council and Staff
February 10, 2010	Hualapai Tribal Council
March 1, 2010	Paiute Indian Tribe of Utah Tribal Council
March 2, 2010	Shivwits Band of Paiute Indians Tribal Council
March 8, 2010	Hualapai Cultural Resources Staff
March 12, 2010	Navajo Historic Preservation Department
March 16, 2010	Kaibab Paiute Tribal Council and Staff
March 26, 2010	Hopi Cultural Preservation Department
April 6, 2010	Havasupai Tribal Council
May 18, 2010	Pueblo of Zuni Tribal Council and Staff
June 1, 2010	Paiute Indian Tribe of Utah Tribal Council
June 9, 2010	Kaibab Band of Paiute Indians Tribal Council and Staff
June 15, 2010	Hualapai Cultural Resource Staff
June 23, 2010	Hopi Cultural Preservation Office
June 23, 2010	Navajo Historic Preservation Department
July 8, 2010	Havasupai Tribal Council
September 14–15, 2010	Intertribal Meeting (Havasupai, Hualapai, and Hopi tribal members)*
February 23, 2011	Hopi Cultural Preservation Office
February 24, 2011	Navajo Historic Preservation Department
February 25, 2011	Paiute Indian Tribe of Utah Tribal Council
February 28, 2011	Hualapai Cultural Resources Department
March 1, 2011	Kaibab Paiute Tribal Council
March 1, 2011	Kaibab Paiute public meeting*
March 4, 2011	Havasupai Tribal Council
March 16, 2011	Pueblo of Zuni Historic Preservation Office
March 24, 2011	Hualapai Tribal Council
March 24, 2011	Hualapai Tribal Council public meeting*
March 31, 2011	Havasupai Tribe public meeting*
April 25, 2011	Western Navajo Nation public meeting*
July 27, 2011	Kaibab Paiute Tribal Council and staff

Table 5.4-1. Tribal Meeting Summary (Continued)

Date	Attendees
August 2, 2011	Pueblo of Zuni Tribal Council
August 2, 2011	Navajo Historic Preservation Department
August 3, 2011	Hopi Cultural Preservation Office
August 17, 2011	Hualapai Tribal Council and Cultural Resources Department
September 12, 2011	Havasupai Tribal Council
September 17, 2011	Paiute Indian Tribe of Utah Tribal Council

* Does not represent official government-to-government consultation.

5.5 ENDANGERED SPECIES ACT AND NATIONAL HISTORIC PRESERVATION ACT COMPLIANCE

5.5.1 Endangered Species Act Compliance

Section 7 of the ESA requires federal agencies to ensure that their actions do not jeopardize the continued existence of threatened or endangered species or result in the destruction of their designated critical habitat. It may also require consultation with the USFWS in making this determination.

The BLM requested informal consultation with the USFWS under Section 7(a) (2) of the ESA on August 8, 2011, requesting concurrence on the determination that the Northern Arizona Proposed Withdrawal may affect, but is not likely to adversely affect, the endangered Brady pincushion cactus *(Pediocactus bradyi*), the endangered California condor (*Gymnogyps californianus*), the endangered humpback

chub (*Gila cypha*) and its critical habitat, the endangered Kanab ambersnail (*Oxyloma haydeni kanabensis*), the threatened Mexican spotted owl (*Strix occidentalis lucida*) and its critical habitat, the endangered razorback sucker (*Xyrauchen texanus*) and its critical habitat, the endangered sentry milk-vetch (*Astragalus cremnophylax* var. *cremnophylax*), the threatened Siler pincushion cactus (*Pediocactus sileri*), the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) and its critical habitat, the endangered Virgin River chub (*Gila seminuda*) and its critical habitat, the endangered woundfin (*Plagopterus argentissimus*) and its critical habitat, and the endangered Yuma clapper rail (*Rallus longirostrus yumanensis*).

The USFWS issued a concurrence letter to the BLM on August 29, 2011, agreeing with the determination that the withdrawal may affect, but is not likely to adversely affect, the stated species. The general rationale for concurrence as stated in the letter is:

> "The proposed action will remove potential effects to these species and their critical habitat associated with the location of new mining claims for 20 years and threats associated with development of most of the existing claims within the withdrawal area."

The concurrence letter also includes species-specific concurrence rationale.

5.5.2 National Historic Preservation Act Consultation

Section 106 of the NHPA requires that federal agencies consider the effects of their actions on historic properties (including archaeological sites) that are listed, or are determined eligible for listing, on the National Register of Historic Places. In doing so, the lead agency must consult with Indian tribes, interested members of the public, and the appropriate State Historic Preservation Officer (SHPO).

The ultimate goal of consultation is to identify and resolve any adverse effects of an undertaking on eligible historic properties.

The BLM initiated consultation with SHPO by letter dated March 12, 2010. Additional correspondence was provided on February 25, 2011, with several documents containing detailed information, including the DEIS, a Class I cultural resources overview, and a summary report on ethnographic resources of the region.

A letter was issued to SHPO on June 16, 2011, requesting concurrence that the Northern Arizona Proposed Withdrawal does not have the potential to cause adverse effects on historic properties. The letter was signed with concurrence by SHPO on July 5, 2011. (BLM 2011b).

5.6 DRAFT ENVIRONMENTAL IMPACT STATEMENT PUBLIC COMMENT

The Draft EIS was published by the BLM on February 18, 2011, and provided to the public for public review and comment. The Draft EIS was distributed in both paper and electronic formats and was available for downloading from the BLM project website, at BLM and Forest Service offices, and at regional public libraries. The BLM invited public and agency comment on the DEIS for a period of 45 days. Four public meetings were held March 7 through March 10, 2011, in Phoenix, Flagstaff, and Fredonia, Arizona, and Salt Lake City, Utah, to present the DEIS to the public, answer questions about the document, and receive public comments. Upon receiving multiple requests to extend the 45-day comment period, the BLM extended the comment period to 75 days, ending on May 4, 2011.

All comments received by BLM were read, categorized, and coded for substantive comments. The Dear Reader letter in the DEIS requested that comments to the DEIS be substantive in nature and that the comments do one or more of the following:

- question, with reasonable basis, the accuracy of information in the DEIS.
- question, with reasonable basis, the adequacy of, methodology for, or assumptions used for the environmental analysis.
- present valid new information relevant to the analysis.
- present reasonable alternatives other than those analyzed in the DEIS.
- cause changes or revisions in one or more of the alternatives.

BLM received a total of 296,461 comment submittals on the DEIS. All comment submittals were recorded into an electronic database. Comments were received from federal, state, and local agencies, advocacy groups (environmental and industry), mining industry, business owners, individuals, and others. Table 5.6-1 illustrates the general number of comment submittal types received by BLM. Comments were submitted both electronically and in hard copy at meetings or by mail. Twenty four different form letters, which accounted for 295,295 of the submittals (99.6%), were received from a variety of organizations and their members. Form letters included identical text and additional text deemed non-substantive comment. Form letters that contained supplementary text deemed substantive comment were identified as "form-plus" submittals and totaled 7. Unique submittals were submitted by individuals and organizations and contained unique content.

Form letters were received from several organizations with most submitted by email and some coming in hard-copy. Each form letter was identified, tallied, and coded into the database one time. The form letters did not contain substantive comments, as defined above. The form letters were coded into a miscellaneous category that identified alternative preference, if applicable. The total number of form letters by organization is listed in Table 5.6-2.

Table 5.6-1. Total Comment Submittals by Type

Category	Electronic	Hardcopy	Total
Total submittals	295,411	1,050	**296,461**
Form letters*	294,467	828	**295,295**
Form-plus**	5	2	**7**
Unique	939	220	**1,159**

*Includes 10,004 Form Letters containing extra comment information deemed non-substantive

**Form letters that included one or more substantive comment

Table 5.6-2. Total Number Form Letters by Submittal and Organization

Form Letter Number / Sender or Description	Miscellaneous Code	Total
Form 1 – Unknown Sender	Alternative B - Proposed Action	**63**
Form 2 Sierra Club	Alternative B - Proposed Action	**404**
Form 3 - Change.org	Alternative B - Proposed Action	**33,230**
Form 4 - Environment Arizona	Alternative B - Proposed Action	**555**
Form 5 – Unknown Sender	Alternative B - Proposed Action	**7**
Form 6 - Pew Environment Group	Alternative B - Proposed Action	**18,667**
Form 7 - Care2	Alternative B - Proposed Action	**24,887**
Form 8 - Wilderness Society	Alternative B - Proposed Action	**5,530**
Form 9 - Kanab Postcard	Alternative B - Proposed Action	**96**
Form 10 - Sierra Club Postcard	Alternative B - Proposed Action	**84**
Form 11 - Just Say No Postcard	Alternative B - Proposed Action	**373**
Form 12 - Same as Form 1	Alternative B - Proposed Action	**150**
Form 13- Aktion Gruppe- German origin	Alternative B - Proposed Action	**62**
Form 14 - AVAAZ	Alternative B - Proposed Action	**55,505**
Letter Generator 15 - North West Mining Association	Alternative A - No Action	**196**
Form 16 – Unknown Sender	Alternative B - Proposed Action	**137**
Form 17 - Defenders of Wildlife	Alternative B - Proposed Action	**1,515**
Form 18 - Change.org	Alternative B - Proposed Action	**50,281**
Form 19 – Unknown Sender	Alternative B - Proposed Action	**11,935**
Form 20 - League of Conservation Voters	Alternative B - Proposed Action	**12,992**
Form 21 - National Parks Conservation Association	Alternative B - Proposed Action	**14,036**
Form 22 – Unknown Sender	Alternative A - No Action	**246**
Form 23 - Credo Action	Alternative B - Proposed Action	**64,325**
Form 24- No Mines Postcard	Alternative B - Proposed Action	**19**

Each submittal was read and all substantive comments were recorded into the electronic database. Table 5.6-3 contains the categories and numbers of substantive comments received on the DEIS. Comments were categorized into DEIS resource topics and general NEPA topics. The miscellaneous category tracks the alternative preference of all submittals. It is important to note that each form letter was counted one time in the miscellaneous category.

Table 5.6-3. Total Substantive Comments by Category

Substantive Comment Subject	Subtotal	Total
Air Quality		56
Alternative		23
Cultural and American Indian Resources		65
Economics		125
Fish and Wildlife		40
Geology and Minerals		34
Miscellaneous (Alternative Preference)		1,103
Alternative A	67	
Alternative B	1035	
Alternative C	1	
Alternative D	0	
Mitigation/Monitoring		70
NEPA		186
Proposed Action	15	
Document Layout	10	
Review Timeline	12	
Purposed and Need	2	
General Impact Analysis	128	
General Cumulative Impacts	11	
Procedural NEPA Violation	8	
Reasonably Foreseeable Development		96
Recreation		6
Social Conditions		57
Soils		17
Soundscapes		8
Special Status Species		41
Vegetation		28
Visual Resources		11
Water Resources		135
Wilderness		18
Total		**2,119**

All substantive comments were analyzed for potential content changes to the DEIS. Each comment received a response that outlines any change that was made for the FEIS or the rationale for no change. All substantive comments are listed below in Table 5.6-4.

Table 5.6-4. Response to Comments

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Air Quality and Climate				
Robert Grossman	54251	1	Air pollution-will you require the mine specific EIS's to contain the details of emissions controls over excavation, placing of ore into trucks, control of emissions from travelling trucks, and unloading at the off-site mill? Who will monitor the foregoing?	Please refer to Chapter 4.2.4 - Compliance with Environmental Regulations and Permitting. The jurisdiction of the agency issuing the air permit for the mine and processing facility must enforce those permit conditions related to compliance (e.g., mitigation measures, emission limitations, and control strategies, etc.). It would be the responsibility of the mine to comply with the conditions of their individual air quality permit. Furthermore, the owner/operator of each mine would be required to conduct air monitoring and recordkeeping to document compliance with those requirements. In addition, the responsible regulatory agency will ensure compliance with the air quality permit by conducting unannounced inspections of the mines.
Kaibab Band of Paiute Indians	246166	3	All alternatives studied in the Draft EIS indicate that we need a comprehensive and refined modeling analysis of the potential collective impacts (quantitative and qualitative) beyond visibility issues, of fugitive emissions resulting from all of the mines' activities, plus its transports along the unpaved routes leading to and including Mount Trumbull Road and highways through our region.	Section 4.2 will be revised to include a discussion of past, present, and future impacts from mining activities. This revision will also include a discussion of the potential cumulative impacts from existing air quality and future mining activities. However, a site-specific impact analysis would be required for all proposed future mining activity. That analysis would include refined dispersion modeling based on data for the specific mine.
Sustainable Economic Development Initiative	54353	7	Some of the negative factors resulting from not withdrawing this land from mineral exploration and mining which are not adequately covered in the DEIS include fugitive uranium dust from haul trucks and accidents. Much more fugitive uranium dust and other air pollutants would impact the populations of 20 Northern Arizona and Southern Utah cities and towns than is counted in the DEIS. In its estimate of 42,345,000 pounds of fugitive dust and other air pollutants from uranium ore mined in the impact area, the DEIS does not include uranium ore dust escaping from haul trucks traveling over 184.4 million miles on trips between mines and White Mesa Mill, or any spills that might be caused by the 367 accidents that are expected during the 300,165 trips between mine and mill. **(See the attached spreadsheet for this analysis of US Department of Transportation data) (Refer to table on page xx)**	Chapter 4.2.4, Table 4.2-15. Total Emissions in Tons (20-year time frame) (page 4-25); lists 17,645.08 tons of PM10 or 35,290,160 pounds of PM10 over a twenty-year time frame would be released under Alternative A. Those values represent PM10 emissions associated with the entire mining process (e.g., exploration, development, mine operations, etc.). With respect to the criteria pollutants generated by the haul trucks, these emissions are associated with the re-entrainment of existing particulates (i.e., dust on roadways, tire/brake wear, and tail-pipe emissions). The haul trucks are designed such that the material being transported is covered in such a way that the ore being hauled is controlled/mitigated and not allowed to escape the vehicle as a fugitive source. While the possibility exists for ore haul truck accidents, there are no data available to estimate emissions from accidental releases. Language has been added to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Section 3.2.2. Legal and Regulatory Requirements, to identify the applicability of 49 CFR Part 171, 172, and 177 to the transport of uranium ore from the mine location to the processing facility. Those regulations were promulgated by the U.S. Department of Transportation and provide the regulatory basis and requirements for such transport.
Sustainable Economic Development Initiative	54353	8	Some of the negative factors resulting from not withdrawing this land from mineral exploration and mining which are not adequately covered in the DEIS include system effect impacts. The DEIS focuses on quantifying the impacts of mineral exploration and mining in many specific characteristics of the area, e.g., air quality, soil, waterm vegetation, fish and wildlife, visual and cultural resources, etc. These components are also part of a larger system which is greater than the sum of its parts, and includes the overall economic vitality, social well-being, and environmental health of the region. The DEIS, however, does not adequately account for the negative impact of these systems effects (particularly on a full cost, life cycle accounting basis) if the land is not withdrawn (Alternatives A, C, or D). For example, air pollution estimates do not include the air pollution generated from other parts of the system of exploration and mining on these parcels, or pollution that occurs outside the immediate area, such as the air pollution from: generating the energy required for pumps to surface 316 million gallons of ground water, refining and transporting the fuel for all the vehicles and other machinery used in mining and transportation, and generating the electricity used in mining and related operations. While these air pollution impacts might be considered indirect or not local, these negative impacts are not included in the indirect mentioned in the DEIS.	The EIS calculates direct operational emissions (e.g., exploration, mine development, mine operation, etc.) in Section 4.2.3. The refining of the ore was not considered as part of the scope of this EIS since it is already analyzed as a part of the uranium mill permitting process. Arizona 1 was used as the analogous mine and the water pumps are presumed to be electrically powered. The emissions from the electrical generation required for pumping 316 million gallons of ground water to the surface were not considered because it would be speculative to assume it was generated by any particular fuel or was derived from any particular source.
Sustainable Economic Development Initiative	54353	9	Examples of other effects not considered in the DEIS include significant weather changes over the next 20 years, including extreme storm events increasing in severity and frequency that might breach containment ponds; and the probable increase in drought conditions in the Southwest that would change stream, spring, and well levels and the relative concentrations of mining pollution and uranium leaks into water tables and potentially the Colorado River.	Please refer to Chapter 4.2.3 - Climate and Greenhouse Gas Emissions (page 4-16). The current available science does not allow for the calculation or prediction of changes in climates at a regional scale that might allow a statistical estimate of such events. NEPA requires analysis of impacts from or to events that are reasonably foreseeable. Since extreme storm events as you describe are unusual and unpredictable. They are not considered reasonably foreseeable
Herbert Alexander	54361	1	At a recent meeting of the Kanab City Council, the higher cost of health insurance for city employees, six of whom are suffering from the effects related to air born radiation, was discussed. Because we are considered "Down Winder's" from the effects of being down wind of previous nuclear testing in Nevada, insurance carriers charge us a higher premium. Has this problem been taken into consideration by your team? If so, what conclusions did you come to, and why?	The higher cost of insurance charged to "down winders" has not been considered in the EIS because an increase or other impact on insurance premiums is not reasonably foreseeable since neither extraction and hauling of uranium ore, nor withdrawal of the area from the mining law is expected to have any effect on the cost of insurance premiums.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Herbert Alexander	54361	3	As there will be many trucks loaded with radioactive material and driving through radioactive dust at the loading point traveling through the heart of Kanab, what studies did you do about contamination of trucks before they leave the mine and the processing plant. Also, as trucks will be stopped at the red light in town and will be in close contact with buildings and pedestrians, are there systems in place to minitor radiation there and other places in the city and on public roads. As has been noted repeatedly on the news since the Japan crisis, no amount of radiation is safe.	The transportation of uranium ore is regulated under 49 CFR 171, 172, and 177 and compliance with those regulations would be a requirement of any mining operation. Monitoring for gamma radiation along the haul route from the mine through Fredonia and Kanab has been underway since ore hauling from the Arizona 1 mine has resumed. To date that monitoring has not shown any detectible radiation emission from the haul trucks along the monitored route. Gamma radiation monitoring would be recommended for future mines in the region to assure that hauling of ore remains safe.
Anonymous	104132	1	Please be advise that there has not been enough research and examination documented that can prove that uranium mining will not affect not only the air but also the groundwaters and aquifers that flow throughout the area within Grand Canyon.	Please refer to Sections 4.2.5 through 4.2.8 of Chapter 4 in the EIS for the discussion on impacts to Air Quality from each of the alternatives. Each mine is required to obtain an ADEQ-issued air quality permit and must adhere to federal, state, and local regulations for the protection of ambient air quality.
Rich Csenge	221984	1	The prevailing wind direction is Southwest. Typically, the strongest and most consistent winds are southwesterly. The EIS states that an average springtime wind speed at the Kanab Airport is 9.5 mph. Of course, it is not the average wind speed that will carry contamination from mines to inhabited locales; it is the high velocity windstorms which are occurring more frequently now with climate change, that are important in this assessment. Southwesterly winds of 30 to 50 miles per hour, occasionally 70 mph, are not uncommon in Kanab.	The Arizona Department of Environmental Quality issues Air Quality Permits to a mine based on their ability to comply with state Air Quality regulations and standards. It is the responsibility of each mine owner/operator to maintain compliance with their air permit, which would have conditions to limit fugitive dust emissions. If winds of 70 mph are reasonably foreseeable at a mine site, it would be factored into compliance requirements for the Air Quality Permit issued by ADEQ.
American Clean Energy Resources Trust (ACERT)	225256	23	Comment: Tables 3.2-4, 3.2-5 and 3.2-5 summarize emission sources in and near the withdrawal area. A new cement plant at Drake, AZ, a few miles south of Ash Fork. is complete or nearly complete. The area is part of the Coconino Plateau. The cement plant and its associated limestone mine should be included in the list of emissions sources, as its emissions will be significant, and it will help put emissions from uranium mining in perspective. Its emissions will be many times that of all the anticipated uranium mines combined.	The Drake Cement Plant has been added as a source to Table 3.2.4. We concur the cement plant is a major federal source of air pollutants and those emissions have been considered in the Air Quality Cumulative Impacts analysis in Section 4.2.
American Clean Energy Resources Trust (ACERT)	225256	61	Page 4-9 Statement: *It was assumed that the entire surface of the 1.1-acre exploration site and 20- acre mine site would be disturbed and that the access roads would be 14 feet wide.* Comment: Far less than 100% of the exploration drilling area would be disturbed. Since no grading is involved, shrubs and grasses would be eliminated only by being crushed or broken by the vehicles driving on them and the root systems would remain intact. Depending on the type of plant and time of year many of the plants would begin to regenerate from the roots as soon as activity in the area ceases.	Section B.4.3 of Appendix B (RFD) describes the expected disturbance associated with exploration. The description in that section states that "Overall, the surface disturbance associated with a typical exploration project amounts to less than 2 acres" and would include all disturbance you have described in your comment. The assumption of 1.1 acres of disturbance for an exploration project is provided for

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			An area of perhaps 50 square feet might be occasionally disturbed to bury excess cuttings which will not fit back in the drill hole. It has been determined by many measurements in the field that cross-country access routes to exploration sites are defined by two tracks where the wheels of vehicles traversed, with an essentially undisturbed strip between. The outside width is a little over 8 feet wide, with a 2 to 2 1/2 foot wide undisturbed strip between the tire tracks. Thus, instead of the assumption, you now have facts based on experience.	analysis purposes in the RFD in Section B.8.1.
American Clean Energy Resources Trust (ACERT)	225256	62	Pages 4-10 thru 4-4-13 Statement: *During exploration, development, and mining operations, both on- and off highway vehicles/equipment would generate gaseous exhaust emissions. Use of ultralow- sulfur diesel fuel for vehicles and generators was also applied in the inventory. Table 4.2-4 summarizes the on-road equipment and vehicle roster for each of the various mine stages.* Comment: This section goes into detail listing vehicles and equipment used, and the amount of emissions from them, however it does not put the emissions in perspective. The public would be able to see the significance of the emissions if they were compared to emissions from vehicles traveling 1-40, Routes 64 and 180 to the South Rim, Route 89 from Flagstaff to Page, Route 389 from Fredonia to St George, 1-15, 1-17, Phoenix city traffic, Flagstaff city traffic, and St George city traffic, especially in summer when these roads are crowded with tourist traffic. It would be especially helpful if emissions from the Navajo Generating Station were listed. Although some of this information is given in tables 3.2.4 and 3.2.5 it is separated in the report so far from the mining emissions section (4.2.3) that the average member of the public will not make the comparison. A comparison of all sources of emissions in northern Arizona and southern Utah would show that emissions generated by mining and ore hauling are negligible. The sources of emissions other than mining in northern Arizona should be listed in section 4.2.3 so that the public can readily make the comparison. A spread sheet listing all sources of emissions including mining in northern Arizona would be appropriate. If the EIS is trying to avoid showing that mining emissions are negligible, then the above does not apply.	The purpose of the EIS is to analyze and compare the impacts of the proposed action and its reasonable alternatives, not to compare the impacts of this action to other, unrelated, unanalyzed actions. Section 4.2 of the EIS is an estimate of the Air Quality impacts to a level of detail sufficient to compare differences between alternatives.
American Clean Energy Resources Trust (ACERT)	225256	63	Page 4-10 Table 4.2.3 Dust emissions from exploration drilling. The EIS gives an estimate for amount of dust emitted in exploration drilling. Normally exploration drilling is done with water/foam injection so that no dust is emitted from drilling of the hole. This fact needs to be brought out in the EIS and corrected in the table. The soap used to produce the foam is biodegradable and non-toxic, and approved for use in drilling domestic and municipal water wells.	While the commenter notes normal exploration drilling is done with water/foam injection, there exist other drilling techniques that do not. Exploratory drilling can be accomplished with techniques such as sonic, air rotary and auger drilling which have the potential to emit fugitive dust. Therefore, not all exploratory drilling techniques provide 100% fugitive dust emission reduction. There was no change made to the EIS. To address the different characteristics of various drilling techniques would require site-specific analysis of a particular drilling proposal.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
	225256	64	Pages 4-25 to 4-36; Page 2-33, Table 2.8-1 Comment: Under Alternative A the amount of emissions produced by 30 mines over a 20-year period are: NOx = 4,156 tons, S02=10 tons, CO=2,922 tons, PM10=17,645 tons, PM25=2,532 tons, VOCs=431 tons, and CO2=399, 100 tons. This is from the exploration stage through reclamation of each mine. 1. Although these figures are correct they do not present a pragmatic picture to the reader. It is best to give the figures on a per mine, per year basis. Thus the figure would be: NOx =23.1 tons/mine/yr, S02=0.055 tons/mine/yr, CO=16.2 tons/mine/yr, PM10=98.0 tons/mine/yr, PM2.5=14.1 tons/mine/yr, VOCs=2.4 tons/mine/yr, and CO2=2,217.2 tons/mine/yr. 2. These figures indicate that the emissions are not excessive and not liable to cause major atmospheric pollution. 3. It might also be instructive to compare this with the emissions caused by the motor vehicles actually entering the Grand Canyon National Park on a daily basis. 4. There is generally some construction within the Park boundaries and in the population areas surrounding. How do the emission figures for the mining compare with that construction?	The annual data per mine in average tons per year have been added to Table 2.8.1. Please refer to Chapter 4.2.3, Table 4.2-7 for the typical mine projected facility-wide annual emissions in tons per year. While the comparisons suggested may be interesting and provide context for some readers, the purpose of the EIS is not to draw comparisons, but to estimate the impacts of the proposed action and alternatives.
Energy Fuels Resources	225260	18	Section 4.2.3. Page 4-10 Fugitive dust estimates for exploratory drilling is high based on the fact that most of the drill holes lose circulation within the first 100' of the hole and it is necessary to use water and foam to maintain the condition and competence of the hole during drilling operations, thereby eliminating any dust being generated from the drilling operation.	The emission factor used to predict fugitive dust emissions from exploratory drilling was not derived from hole depth. The emission factor assumes fugitive dust emissions on a pound per hole basis. The emission factor predicts a mass of 1.3 pounds per hole drilled and is a fraction of the total dust emissions associated with the mine from development to closure.
Energy Fuels Resources	225260	19	Section 4.2.4. Page 4-24: In the last paragraph, it states that *"It is possible that emissions from proposed mine operation activities could impact the Park. However, this is relative to the location of the actual proposed mine within the parcel and must be determined for each source location.* While this may be theoretically true, the regulations do not allow for this to occur. It is recommended that language from page ES-13 of the executive summary be added here to clarify that *Current governing laws and regulations would require any future exploration and development activities to demonstrate that the proposed activity would not impact Class I areas ..*	The FEIS has been revised as suggested in Section 4.2.4.
Energy Fuels Resources	225260	20	At the same time, the DEIS fails to calculate the GHG reductions that is represented by the uranium energy resource. A calculation can determine the GHG reduction from the energy content of the uranium and then by subtracting the amount generated would be the net benefit. For example, the amount of uranium in the withdrawal areas would produce enough fuel to equivalently run the Navajo Generating Station (NGS) for over 77 years. The NGS produces 20.1 million tons of C02 per year. The total offset of C02 by using uranium as a fuel is 1.56 billion tons of C02. The production of C02 by uranium exploration and mining in the withdrawal area was calculated at 399,100 tons, therefore; a net savings of nearly 1.56 billion tons of C02 is generated by using uranium from the withdrawal area as	The EIS does not include an analysis of GHG "offsets" (i.e., uranium as a replacement for other energy sources) for several reasons. First, there is no guarantee that uranium mined from the proposed withdrawal area would be allocated exclusively to energy production. Some percentage may go to defense uses, medical applications, or other uses. In addition, with notable exceptions such as Iran and North Korea, processed uranium may be legally sold on the open market and shipped anywhere in the world. Finally, there is no assurance uranium would be

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			nuclear fuel.	used to replace—rather than simply augment—other energy sources such as coal, natural gas, hydroelectric, solar, or wind power. The analysis the commenter requests is beyond the scope of the EIS because the proposed action is a withdrawal of certain lands from location of hardrock mining claims that might result in the production of uranium, not the approval of any particular plan of operations or even consideration of the sitting and/or development of a nuclear reactor that might use uranium to produce electricity.
Uranium Watch	225262	6	The DEIS does not assess the impacts of the emissions of radon and radon progeny from the site.	Please refer to Chapter 4.2.4 - Hazardous Air Pollutant Impact Assessment (pages 4-19 through 4-20). The mine specific air quality permit would prohibit the emissions of radon from the underground uranium mine in excess of those amounts that would cause humans to receive an effective dose equivalent to 10 millirem per year. The mine would be required to demonstrate compliance with this 10mrem/yr limit using the EPA's COMPLY-R mathematical model (or equivalent).
Uranium Watch	225262	15	Section 2.8, Comparison of Alternatives; Table 2.8-1, Summary of Potential Environmental Impacts by Alternative; Air Quality and Climate. Page 2-33. This section does not provide any assessment of the emission of radioactive and non-radioactive pollutants from the uranium mines. There is no assessment of the emission of radon and radon progeny from radon vents and mine portals, whether or not the specific mining operation falls under the requirement of 40 C.F.R. Part 61, Subpart B National Emission Standards for Radon Emissions from Underground Uranium Mines. There is no assessment of the emission of radon gas and radioactive particulates from ore storage areas, waste rock dumps, evaporation ponds, mine-water cleanup operations, and other mine facilities. There is no assessment of the release of silica and non-radioactive hazardous emissions from uranium mining operations; for example, silica particles, arsenic, diesel fumes. The EIS must characterize the potential radiological and non-radiological emissions from existing, potential, and historic uranium mining activities in the area of the proposed withdrawal. The impacts of these emissions on the environment must be assessed.	A separate column for radon emissions (10 mrem/yr) has been added to Table 2.8-1. Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Additionally, particulate emissions were calculated on a "generic" particle basis according to their particle size (i.e., PM10 and PM2.5). Individual site-specific conditions could be used to determine the specific make-up of the class of particle sizes for the site, specific to the individual mine.
Uranium Watch	225262	18	Section 3.1.7 Resource Condition Indicators Table 3.1-1; 3.2 Air Quality; Quantity of criteria and hazardous air pollutants; Description of Relevant Issues. Page 3-4. This section must state that the effective does equivalent is 10 millirems per year. The draft EIS left out per year after 10 millirems. This section also gives the impression that all of the potential	The EIS has been revised in Section 3.2 to include "per year" after 10 mrem. Table 3.1-1 has been revised to include the applicability threshold for 40 CFR Part 61 Subpart B. The text has been revised to read, "Radon-222 emissions from the underground mining

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			uranium mining operations would fall under the federal standard in 40 C.F.R. § 61.22. This is not the case. The 10 millirem per year standard only applies to mines that have mined or plan on mining 100,00 tons of ore over the life of the mine. See 40 C.F.R. Part 61, Subpart B. This section fails to discuss the fact that there are no emission standards for uranium or other radioactive particulates at uranium mines; no standard for the emission of radon from sources on the surface, such as waste rock piles, evaporation ponds, and ore storage areas; and no standards for emission of silica and other hazardous materials that are present at uranium mining operations	activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] (for mines exceeding 10,000 tons per year of ore production) and...". The applicability of 40 CFR Part 61 Subpart B defines which individual processes are subject to the emission limitations established in the regulation. A mine whose production is less than 10,000 tons of ore per year or 100,000 tons of ore over its lifetime is not subject to 40 CFR Part 61 Subpart B.
Uranium Watch	225262	20	Section 3.2.2 Legal and Regulatory Requirements; National Emission Standards for Hazardous Air Pollutant. Page 3-20. This section references 40 CFR Part 61, Subpart T as a regulation that is potentially applicable to uranium mining and processing activities. Subpart T has been rescinded with respect its application to active uranium processing facilities. The EIS should include the legal and regulatory requirements for uranium processing facilities, including the Atomic Energy Act and Nuclear Regulatory Commission and State of Utah regulations applicable to the White Mesa Uranium Mill.	The processing of the uranium ore at the White Mesa Mill was not evaluated in this EIS because it is out of scope for this analysis and was analyzed as a part of the mill permitting and authorization process.
Uranium Watch	225262	21	Section 3.2.2 Legal and Regulatory Requirements; State Laws and Regulations. Page 3-20. This section states that *the ADEQ has been delegated authority to administer and enforce the Clean Air Act (CAA) federal, and state regulations and standards in Coconino and Mohave counties.* This statement is misleading. The ADEQ has not been granted authority to administer and enforce the radionuclide National Emission Standards for Hazardous Air Pollutants (NESHAP). Specifically, 40 C.F.R. Part 61, Subpart B is administered and enforced by the Environmental Protection Agency (EPA), Region 9. Arizona does have the authority to establish and enforce its own NESHAP standards.	Text in document Section 3.2.2 has been revised to say: "ADEQ has been delegated the authority to administer and enforce the CAA, federal, and state regulations and standards in Coconino and Mohave counties, Arizona (location of the proposed withdrawal parcels); with the exception of those regulations at 40 CFR Part 61 Subpart B. Those regulations are administered by Region 9 of the EPA."
Uranium Watch	225262	22	Section 3.2.4 Current Value Resource Condition Indicators; Table 3.2-8 Air Quality Resource Condition Indicators. Page 3-29. Again, the does standard for some (but not all) underground uranium mines is 10 millirems per year for the exposure to the nearest receptor (residence, place of work, school, agricultural enterprise). See 40 C.F.R. Part 61 Subpart B. The discussion of regulatory requirements fails to include the requirement for Subpart B regulated uranium mines must submit an application to and receive approval from the EPA and submit annual Subpart B compliance reports to the EPA.	The language in Section 3.2.4 has been revised to include that a regulated uranium mine under 40 CFR part 61 subpart B must submit an application and annual Subpart B compliance reports to the EPA.
Uranium Watch	225262	29	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Introduction (Section 4.2.1) lists the emissions from construction and operational sources. However, it fails to list the emission of uranium and other radioactive particulates from the mining operation. This would include radioactive particulates from ore handling and loading operations, ore	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			storage areas, waste rock piles, contaminated soils, water treatment facilities and other sources of radioactive particulate emissions at the mines. The consideration of fugitive dust emissions fails to address this important aspect of uranium mine emissions.	environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Chapter 3 has been revised to include a discussion of the background levels of radon and radioactivity.
Uranium Watch	225262	30	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Introduction fails to list the emissions of silica, arsenic, and other non-radioactive particulates from the mining operation that are a hazard to public health and the environment	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Addition text has been added to Section 4.2 explaining why airborne silica and arsenic are not discussed in the EIS.
Uranium Watch	225262	31	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Introduction fails to list the radioactive and non-radioactive constituents of the uranium ore and waste rock that have the potential to adversely impact the human health and the environment	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. Each individual mine proposal would be required to prepare its own environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines would be analyzed in more detail in that document.
Uranium Watch	225262	32	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Introduction fails to list the emission of radon from the above ground uranium mining operation, including any mine-water treatment facility. The Introduction fails to list all potential radioactive and hazardous emissions and consider the fact that these emissions may not be monitored or regulated in any way; for example, the emission of radon and radioactive particulates from the surface mining operation are not monitored or regulated	Impacts of radon emissions are estimated in Chapter 4 Section 4.2.4 (Hazardous Air Pollutant Impact Assessment) to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document.
Uranium Watch	225262	33	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The DEIS discussion of Impacts Common to All Alternatives (Section 4.2.4, page 4-16) manages to totally ignore the radioactive and hazardous constituents of any fugitive dust from the mining operation. The EIS must identify all hazardous radioactive and non-radioactive constituents of fugitive dust from the uranium mining operations and assess their impact on the environment. This would include an evaluation of potential exposure pathways and impacts to the public, workers, ground and surface water,	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			soils, vegetation, and native and domestic animals—over the short and long term.	document. Additional text has been added to Section 4.2.4 explaining what would be included in a site-specific evaluation.
Uranium Watch	225262	39	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The discussion of Mine Closure and Reclamation Impacts on Air Quality (Section 4.2.4, page 4-18) should have provided an evaluation of the time it would take for reestablishment of pre-mining vegetative cover and stabilization of disturbed soil surfaces. The EIS should have discussed the clean-up standard for hazardous radioactive and non-radioactive contaminants at the site that would affect the air quality after reclamation is complete. This would include contaminants from ore pads, waste rock, evaporation ponds, exploration drilling, vent hole sites, contaminated soils, and any other on-site or off-site area that has been impacted by the mining operation.	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Additional text has been added to Section 4.2.4 explaining what would be included in a site-specific evaluation.
Uranium Watch	225262	40	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. This section should have discussed the impacts of hazardous radioactive and nonradioactive contaminants at the site that would affect the air quality during temporary cessation of mining activity.	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Additional text has been added to Section 4.2.4 explaining what would be included in a site-specific evaluation.
Uranium Watch	225262	41	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Hazardous Pollutant Impact Assessment discussion (Section 4.2.4, page 4-19) fails to assess the different exposure pathways and identify the pathways of the relevant pollutants.	The text in Chapter 3 has been revised to include a discussion on the relevant exposure pathways of radon. Section 4.2 will provide a reference with respect to the discussion in Chapter 3. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Additional text has been added to Section 4.2.4 explaining what would be included in a site-specific evaluation.
Uranium Watch	225262	42	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Hazardous Pollutant Impact Assessment discussion (Section 4.2.4, page 4-19) states *that Hazardous Air Pollutants (HAPS) can cause various adverse health effects and are not regulated under NAAQS.* It goes on to state: *High concentrations at the mine site boundary could indicate the need for further analysis and/or mitigation strategies.* Here, the EIS should discuss	Text in Chapter 4 Section 4.2.4 has been revised as follows: "HAPs can cause various adverse health effects. They are not regulated under the NAAQS. However, emission standards for HAPs have been established in regulations contained at 40 CFR 61 and 63. These regulations were established to ensure that

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the type of monitoring that would occur at the site boundary that would be able to identify whether there were unacceptable levels of HAPS moving off site. Unfortunately, there does not appear to be any requirement to monitor HAPS at the mine site boundaries. Therefore, it is disingenuous for the EIS to imply that such monitoring and regulation of HAPS would take place at the uranium mine sites.	HAP emissions do not exceed concentrations determined to be detrimental to human health and the environment." Specific monitoring and mitigation measures to regulate HAPS would be identified and designed in site-specific environmental documentation when a mine is proposed.
Uranium Watch	225262	44	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Hazardous Pollutant Impact Assessment discussion (Section 4.2.4, page 4-20) states: *when radon-222 decays, it releases alpha particles, which have been linked to negative human health effects.* This discussion of the progeny from the decay of radon- 222 and the human health effects is totally inadequate. The EIS should identify the highly radioactive particles that result from the decay of radon-222, how those particles can lodge in the lungs, and the potential "negative human health effects" caused by the inhalation of radon-222 and its decay products, including cancer.	The text in Chapter 3 has been revised to include a discussion on the relevant exposure pathways of radon. Section 4.2 will provide a reference with respect to the discussion in Chapter 3.
Uranium Watch	225262	45	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Hazardous Pollutant Impact Assessment discussion (Section 4.2.4) should have included a full discussion of the various sources of radon gas, uranium, and uranium decay products at the mine sites and how those radioactive elements can impact the human body and the environment.	The text in Chapter 3 has been revised to include a discussion on the relevant exposure pathways of radon. Section 4.2 will provide a reference with respect to the discussion in Chapter 3.
Uranium Watch	225262	46	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. Section 4.2 does not compare the potential for radon emissions from the underground uranium mine operations for the various withdrawal alternatives. The EIS should have discussed the emission of radon from the underground workings at the mine sites and the impact of those radon emissions. The EIS should have estimated and compared the number of curies of radon that would be released into the atmosphere from the underground mines under each alternative.	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Additional text has been added to Section 4.2.4 explaining what would be included in a site-specific evaluation.
Uranium Watch	225262	47	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. Section 4.2 fails to assess the impacts to workers from the exposure to radon, diesel fumes, and other pollutants in the underground mines. The DEIS should include an assessment of the exposure of workers to radon from the mines and the potential for over exposures to these hazardous materials.	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. Additional text has been added to Section 4.2.4 explaining what would be included in a site-specific evaluation.
Uranium Watch	225262	48	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The reference to	Based upon the theoretical 300-tpd mine described in

Table 5.6-4. Response to Comments (Continued)

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			the emission standard for hazardous air pollutants from underground uranium mines (40 C.F.R. Part 61, Subpart B) is irrelevant, because the current and expected breccia pipe mines are not subject to that standard, because the amount of ore mined will be less than 100,000 tons of ore.	the RFD, the total annual production would be 109,500 tons of ore per year. This production rate exceeds the 10,000 ton per year threshold established by 40 CFR Part 61 Subpart B. Consequently, for the purposes of this analysis, we have treated the requirements of 40 CFR Part 61 Subpart B as applying in every case although, as the commenter points out, these standards may not ultimately apply when the surface-managing agency reviews mining plans of operations on a case-by-case basis.
Uranium Watch	225262	49	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The Summaries of the Maximum Total Emissions for the various alternatives totally ignores the emission of radionuclides and non-radioactive hazardous pollutants from the mines. The EIS must address the emissions of radionuclides and non-radioactive hazardous pollutants, such as silica and arsenic for each alternative.	Table 4.2-7 has been revised to include radon emission limitation prescribed in 40 CFR 61, subpart B. Each individual mine's site-specific environmental documentation would conduct impact analysis for its individual pollutants and operations. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document.
Uranium Watch	225262	50	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The discussion of Cumulative Impacts (page 4-36) should have discussed the cumulative impacts from the emission of uranium, radon, and other radionuclides from uranium mining activities in the withdrawal area. The assessment of cumulative impacts should include an evaluation of the current emissions of radionuclides from current and historic uranium mining activity in the withdrawal area	Section 4.2 has been revised to include a discussion of past and present impacts from mining activities. This revision will also include a discussion of the potential cumulative impacts from future mining. Moreover, Chapter 3 has been revised to include a discussion of the background levels of radon and radioactivity.
Arizona Mining Association	225266	9	Section 4.2.5- Climate Impacts While the DEIS considers incremental Greenhouse Gas (GHG) emissions from breccia pipe projects, the DEIS fails to calculate the GHG reductions that is represented by the uranium energy source .. As noted in Energy Fuels Resources Corporation's comments, using the Navajo Generating station as an example, the total potential offset by using uranium as a fuel results in 1.56 billion tons of CO2. Any reasonable search for clean and abundant energy with a minimal carbon footprint would inevitably lead to the vast uranium resources in northern Arizona.	The EIS does not include an analysis of GHG “offsets” (i.e., uranium as a replacement for other energy sources) for several reasons. First, there is no guarantee that uranium mined from the proposed withdrawal area would be allocated exclusively to energy production. Some percentage may go to defense uses, medical applications, or other uses. In addition, with notable exceptions such as Iran and North Korea, processed uranium may be legally sold on the open market and shipped anywhere in the world. Finally, there is no assurance uranium would be used to replace—rather than simply augment—other energy sources such as coal, natural gas, hydroelectric, solar, or wind power.
Grand Canyon	225279	9	The DEIS fails to attempt to analyze the amount and effects of fine	Impacts of emissions are estimated in Chapter 4

Table 5.6-4. Response to Comments (Continued)

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Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity			particulate (PM 2.5) uranium dust originating from mining facilitates. Fine particulate uranium dust emits alpha particles and can enter the blood stream through inhalation, causing health effects to humans and, presumably, other species. The DEIS seems to try to justify this failure by quoting ADEQ's refusal to analyze those effects in its permitting of the Arizona 1 uranium mine north of Grand Canyon.	Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. The variability in ore concentrations and specific site conditions precludes any analysis of greater detail than that already conducted.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	32	The DEIS discloses that Alternatives A, B, C and D will cause 2532, 956, 1472 and 2214 tons respectively of fine particulate matter dust emissions (PM 2.5) over the twenty-year withdrawal period. Fine particulate uranium dust can emit alpha radiation and when inhaled can enter the blood stream and cause harmful health effects. DEIS' Hazardous Air Pollutant Impact Assessment neglects to analyze the potential impacts of fine particulate uranium dust originating from mining facilities and operations. Instead of analyzing those effects, the DEIS quotes ADEQ's Technical Review and Evaluation of Application for Air Quality Permit No. 46700 for Denison's Arizona 1 Mine: Radiation exposure from dust associated with the mining operation is dependent on the concentrations of dust in the air and the activity of the compounds in the dust. Since these values are variable, it is not feasible to estimate the radiation impact from the dust. DEIS 4-20. The DEIS needs to estimate the radiation and exposure effects that would result from all phases of uranium mining. The ADEQ's refusal to analyze those effects does not license the BLM to do the same.	Impacts of emissions are estimated in Chapter 4 Section 4.2 to the level of detail possible for an EIS that is not for a specific mine. In considering approval of a uranium mine plan of operation, the BLM and Forest Service would require site-specific environmental documentation and the impacts from radioactive and non-radioactive pollutants from the uranium mines could be analyzed in more detail in that document. The variability in ore concentrations and specific site conditions precludes any analysis of greater detail than that already conducted.
Ted Jensen	225282	3	Missing from background history are the Nevada nuclear downwinder radiation impacts on the area. The Northern Segregation area is within a heavy radiation fallout area. This radiation is still there including in the trees. Controlled burns on the Kaibab and even on the Grand Canyon Park release this radiation and is carried to Colorado River.	We recognize that there were historical issues with radioactive fallout within the withdrawal parcels by the applicable regulatory authority. The nuclear testing conducted at the Nevada Test Site in the 1940s and 1950s dispersed radioactive material into the atmosphere. This radioactive material was then dispersed over a wide range downwind of the test site as it was deposited as radioactive fallout. This radioactive fallout accounts for much of the background radiation in the area. This background history has been added to Chapter 3 of the EIS. All estimated impacts of emissions from uranium mining are expressed as changes from the background radiation, so are already measured as cumulative with the fallout from the Nevada Test Site.
Ted Jensen	225282	8	If scale logic is used in one area, then they should be applied in others. For example, why is there no air quality magnitude scales used in the Impacts upon Air Quality (ES-13).	The use of "scale logic" is intended to provide context, magnitude, intensity, and duration for impacts that are more qualitative in nature. With respect to impacts on

Table 5.6-4. Response to Comments (Continued)

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				air quality, the use of scale logic is not appropriate because it can be disclosed quantitatively. Air quality standards are established such that emissions and/or projects that emit air pollutants must stay below regulatory thresholds. Exceedance of a regulatory threshold would constitute an adverse impact and an enforceable action. Therefore, you are either above or below the standard.
Quaterra Alaska Inc.	225288	9	P 4-15 Table 4.2-7 Emissions from standby generator. It appears questionable that a generator which is used only for electric power outages would generate 48 tons per year of CO2.	CO2 emissions from the standby generator were calculated based on 500 hours per year of operations and standard methodology obtained from the U.S. EPA's AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors methodology obtained from Table 3.3-1 -Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines dated October 1996.
Lela Rhodes	226422	4	According to Arizona tourist information, in 2009 4.3 million people visited the Grand Canyon National Park. They also state that 74% of those visitors traveled by car. That means that the exhaust from 3,182,000 vehicles in 2009 was dispersed into the environment. Your DEIS touts tourism as the mecca for the area, but you make no mention of this very hazardous environmental activity.	Emission inventory estimates for Coconino and Mohave Counties are provided in Table 3.2-5. 2005 Summary of Emissions by Source (in tons per year) for Coconino and Mohave Counties and Arizona Statewide. This table provides ton per year emissions from on-road gasoline and diesel vehicles.
VANE Minerals	242650	12	A key issue in the DEIS can be found in Section 4.2.5 (Page 4-25), Assumptions for Impact Analysis. This key issue is the mention of reclamation. This implies "temporary" when describing impacts and is the most significant fact in determining whether uranium exploration and mining pose potential harm and proves that a 20- year withdrawal is unjustified and that the segregation was unjustified for that matter.	As described in Appendix B, an important phase in the mine life-cycle is reclamation. Section B.4.5 describes typical uranium mine reclamation practices. While reclamation is required and mining companies are bonded to assure it does, the majority of affects from mining occur while the mine is in active production. Further, mine reclamation may achieve site stabilization from air and water erosion risk in a couple of years, but may take several generations to return to pre-mining conditions.
Groundwater Awareness League, Inc	242658	3	The BLM Report covers the issues with "on-site" mining. There are issues with mining. Unique problems can occur with the mining process. The release of radon is often associated with uranium mining	Emissions of radon from onsite mining activities are regulated under 40 CFR Part 61 Subpart B, which establishes radon emission limits from such activities. EIS Section 4.2 addresses the emissions of radon associated with uranium mining within the proposed withdrawal area.
The NAU Project, LLC	242913	21	Page 1-21 Table 1.5-1 Air Quality and Climate: The detailed analysis of the cumulative impact on air quality was not done. The Cumulative Impacts section in Chapter 4 states: There are other uses and activities for the lands within the proposed withdrawal area besides uranium **Table 1.5-1 states: Air Quality and Climate Release of particulates The release of particulates (dust) from exploration drilling operations, mining, and ore*	The text in Table 1.5-1 has been revised to say "Increase in regional haze emissions from all exploration and development activity and equipment could contribute to the regional haze affecting air quality in the study area, as well as affect overall scenic quality." The cumulative effects of the mining

Table 5.6-4. Response to Comments (Continued)

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			hauling traffic and other vehicles on unpaved roads could have an effect on the regional air quality. This could occur in combination with pre-existing emissions from coal plants, cities, traffic, and other sources of regional air pollution to create a cumulative regional effect on air quality. Increase in regional haze Emissions from all exploration and development activity and equipment could contribute to the regional haze affecting air quality in the defined prevention of significant deterioration area, as well as affect overall scenic quality. Table 1.5-1 cites cumulative impacts when added to coal plants, cities, traffic, and other sources of regional air pollution and Chapter 4 cites recreational activities, OHVs, livestock grazing, etc. Then states that there is not sufficient data to analyze and quantify these sources of potential emissions! While I am sure that getting data for the above activities cited in Chapter 4 is difficult, the detailed analysis specifically called for did not mention any of these. The items to be analyzed in detail were coal plants, cities, traffic, and other sources of regional air pollution. This is an example of BIAS by OMMITION! The cumulative impact analysis is actually quite easy to do and all the relevant data is easy to access. My analysis indicates that the additional pollution at all levels for uranium exploration and mining is negligible compared to the current levels being produced by all sources in the Air Quality Study Area. As the DEIS points out, there will be local affects, and these effects will have to be mitigated or satisfy State and Federal air quality standard in order to receive the permits required to operate a mine. I have provided an outline and methodology of the required detailed analysis for cumulative effects on Air Quality in my comments for Chapter 4. The Cumulative effect analysis needs to be done as required by NEPA.	process are dependent upon the number of simultaneous, active processes. Any future mining activities must comply with those regulations promulgated under the CAA including PSD. Future mining locations would be required to demonstrate compliance with clean air standards promulgated under the CAA. All of the cumulative sources in an air shed plus any future sources cannot exceed the air quality standards.
The NAU Project, LLC	242913	25	Section 1.5.3 Issues Eliminated from Detailed Analysis: The extent to which uranium energy production offsets the use of carbon-based fuels that contribute to the release of greenhouse gases (GHGs), which have been linked to global climate change. This issue was incorrectly eliminated from detailed analysis. The proper analysis would be the amount by which the uranium in the withdrawal area offsets the use of carbon-based fuels that contribute to the release of greenhouse gases (GHGs), which have been linked to global climate change. In other words, the general amount that nuclear power reduces green house gases is not germane to the EIS, but the GHG reduction due to the uranium in the withdrawal area is. After all, the GHGs produced by uranium exploration and mining was minutely calculated and statements in this DEIS specifically commented on them, thus implying while the effect might be unknown, the fact that all these GHGs were being produced was important. Including the GHGs produced by uranium exploration and mining while excluding the GHG offsets is sneaky!	The EIS does not include an analysis of GHG “offsets” (i.e., uranium as a replacement for other energy sources) for several reasons. First, there is no guarantee that uranium mined from the proposed withdrawal area would be allocated exclusively to energy production. Some percentage may go to defense uses, medical applications, or other uses. In addition, with notable exceptions such as Iran and North Korea, processed uranium may be legally sold on the open market and shipped anywhere in the world. Finally, there is no assurance uranium would be used to replace—rather than simply augment—other energy sources such as coal, natural gas, hydroelectric, solar, or wind power.
The NAU Project, LLC	242913	30	Table 3.2-4 seems to be incomplete. The Kayenta Coal Mine should be included. PM10 value is 1,396 tpy. Include any other relevant pollutants	The Kayenta Coal Mine has been added to Table 3.2-4. Additionally, CO_2 emission values for other activities

Table 5.6-4. Response to Comments (Continued)

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			from this source. Grand Canyon Railway operation?? Burning lots of diesel fuel and kicken up dust on their runs to and from the Grand Canyon. Figure out what this operation pollutes each year. Table 3.2-5 has no CO2 values. Chapter 4 calculates CO2 emissions for mining activities and there is no basis to compare with existing sources of CO2 in the Air Quality Study Area. This deficit should be corrected.	in the area have been added as available. Emission inventory estimates for Coconino and Mohave Counties are provided in Table 3.2-5. 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties and Arizona Statewide. These tables provide tpy emissions from non-road equipment and include emissions from trains. GHG emissions from mining were included in the analysis in order to compare the mass emissions of GHG between the proposed action and the alternatives.
The NAU Project, LLC	242913	31	Table 3.2-5 It is unclear whether these figures include the transient traffic that exists on I-40. This major interstate cuts across both Mohave and Coconino counties and supports traffic 24/7 with both diesel and gasoline vehicles contributing air contaminates.	Emission inventory estimates for Coconino and Mohave Counties are provided in Table 3.2-5. 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties and Arizona Statewide. These tables provide tpy emissions from on-road gasoline and diesel fueled vehicles and include emissions from these vehicles traveling on Interstate 40.
The NAU Project, LLC	242913	43	Section 4.2 Air Quality and Climate General comment regarding the effects of uranium mining on Climate. It seems strange to me that the authors felt compelled to indicate that it was possible, but unknown, how the mining of uranium would affect global warming. In section 1.5.3 Eliminated from detailed analysis: *The amount by which the use or non-use for energy production of uranium found in the proposed withdrawal area could change global temperatures.*and *The extent to which uranium energy production offsets the use of carbon-based fuels that contribute to the release of greenhouse gases (GHGs), which have been linked to global climate change*. Yet, the amount of green house gases generated by uranium mining was calculated and a statement was made that they could contribute to global climate change: From page 4-7 *Uranium mining activities in the proposed withdrawal will likely cause localized increases in air pollutant emissions, with the exception of GHG emissions, which are considered by scientists to contribute to global climate change and which could have global impacts.* So it seems to be OK to say that mining uranium in the withdrawal areas will contribute to GHGs and thus could have global climate change impacts, but it is NOT OK to consider the GHG reductions that is represented by the uranium energy resource. This conflict must be resolved, as is, this is a BIAS in the writing of the EIS. A simple calculation can determine the GHG reduction from the energy content of the uranium and then subtracting the amount generated would be the net benefit. The amount of uranium in the withdrawal areas would produce enough fuel to equivalently run the Navajo Generating Station (NGS) for 77.7years. The NGS produces 20.1 million tons of CO2 per year. The total offset of CO2 by using uranium as a fuel is 1.56177 Billion tons of CO2. The production of CO2 by uranium exploration and mining in	The EIS does not include an analysis of GHG "offsets" (i.e., uranium as a replacement for other energy sources) for several reasons. First, there is no guarantee that uranium mined from the proposed withdrawal area would be allocated exclusively to energy production. Some percentage may go to defense uses, medical applications, or other uses. In addition, with notable exceptions such as Iran and North Korea, processed uranium may be legally sold on the open market and shipped anywhere in the world. Finally, there is no assurance uranium would be used to replace—rather than simply augment—other energy sources such as coal, natural gas, hydroelectric, solar, or wind power. GHG emissions from mining were included in the analysis in order to compare the mass emissions of GHG between the proposed action and the alternatives.

Table 5.6-4. Response to Comments (Continued)

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			the withdrawal area was calculated at 399,100 tons. A net savings of 1.56137 Billion tons of CO2 by using uranium from the withdrawal area as nuclear fuel! The net offset of CO2 for the uranium in the withdrawal areas should be calculated and included in the EIS since the CO2 contribution from uranium exploration and mining was calculated.	
The NAU Project, LLC	242913	44	Page 4-5 It is also important to note the possibility exists of the mines' being idle for 20 years. Appendix B states that the RFD assumes the price for U3O8 remains constant at $40/lb and therefore assumes no mines being idle. This sentence should be eliminated.	The sentence has been removed.
The NAU Project, LLC	242913	45 & 46	Page 4-25 Summary of Impacts (Air Quality and Climate) This section is inadequate and that is putting is politely. No context or explanation is given for why any of the emissions listed in the amounts calculated are detrimental (or not) to the regions air quality. Table 4.2-17 tallies the maximum total emissions in tons from all phases of mine operations associated with Alternative A. Under Alternative A, over a 20-year period approximately 3,413 tons NOX, 9 tons SO2, 2,352 tons CO, 15,346 tons PM10, 2,254 tons PM2.5, 371 tons VOCs, and 333,203 tons CO2 would be emitted to the atmosphere during the mine operation activities. So what do these numbers mean? How do they compare to what is already happening in the Air Quality Study area? What percentage increase are the values over what is already being produced? These concepts should be covered in the Cumulative Impacts Section. They are not, the cumulative impacts' section says: There are other uses and activities for the lands within the proposed withdrawal area besides uranium mining (i.e., recreational activities, OHVs, livestock grazing, etc.) However, sufficient data are not currently available to quantify these other potential emission. Really? The author(s) of this section spent a huge amount of time modeling everything to do with the impacts of mining on air quality impacts, but has insufficient data to model the existing air quality? Really? From Table 1.5-1 for air quality: "cumulative impacts" for uranium exploration and minings contributions when added to coal plants, cities, traffic, and other sources of regional air pollution and Chapter 4 cites recreational activities, OHVs, livestock grazing, etc. for the same cumulative impact analysis. Chapter 4 goes on to state that there is not sufficient data to analyze and quantify these sources of potential emissions! While I am sure that getting data for recreational activities, OHVs, livestock grazing cited in Chapter 4 is difficult, the detailed analysis specifically called for did not mention any of these. The items to be analyzed in detail were coal plants, cities, traffic, and other sources of regional air pollution. The lack of data for analysis for cumulative air quality impacts is bull, plain and simple, and represents a significant source of BIAS in the development of this EIS. A back of the napkin analysis shows that the contribution to the total emissions is negligible compared to what already exist. A simple model for the existing emissions for the Study Area	As a matter of law, air pollution emissions are not necessarily detrimental to the region's air quality, unless they exceed regulatory standards. Emissions from mining were included in the analysis in order to compare the mass emissions of air pollutants between the proposed action and the alternatives. The existing background data for the air quality study area is included in Table 3.2-6. Those data represent the available measure background for the area. The measured background data would include existing stationary sources and other air pollutant generating activities. Table 3.2-4 provides emissions data for the PSD sources located in the air quality study area. Table 3.2-5 provides county-wide emissions data for those counties in the air quality study area. When conducting impact modeling with respect to air quality, background concentrations are evaluated in that process. Background emissions are measured concentrations data that includes emissions from all current sources contributing to air quality in the study area including stationary sources, mobile sources, and other use emissions such as cities, power plants, recreational vehicles, livestock grazing, travel on interstate highways, etc. Impacts from these sources in addition to future mines and/or future emission sources would represent the cumulative impact. Section 4.2 has been revised to include a discussion of past and present impacts from mining activities. This revision will also include a discussion of the potential cumulative impacts from future mining. Moreover, Chapter 3 has been revised to include a discussion of the background levels of air pollutant data, including

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			is all that is needed. A simple model is easy to construct and analyze as most of the work and research has been already done for determining the uranium mining air emissions. An outline for this model is presented below. A Proposed Simplified Air Emissions Model For the Air Quality Study Area The Study area is as specified by Figure 3.2-1	GHG. A model for each individual current or existing condition will not be helpful toward understanding the potential impacts of the proposed withdrawal on air quality conditions. None of the proposed mines evaluated in this FEIS would have potential emissions in quantities large enough to trigger a PSD review, as defined in Section 3.2.2. Therefore, it was assumed that each mine would be considered a minor source relative to the PSD permitting process and would only require a State of Arizona Class II Non-Title V air quality permit.
The NAU Project, LLC	242913	45 & 46	Continued... The PSD sources are listed in Table 3.2.-4. I believe the Kayenta Coal Mine has been left off this list. If so, add it to the list. Use Table 3.2-5 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties. Create the same kind of table for Kane and Washington Counties in Utah. Modify each county's emissions by the percentage of people residing in the Air Quality Study Area. This gives a reasonable estimate for the contribution of emissions for each county to the study area. Determine if the county data includes items such as traffic on I40 and Hwy 64 to the Grand Canyon and other more heavily traveled roads. If the data does not include traffic on I40, visitor traffic to the Grand Canyon, hunters, hikers, site seers, etc, within the study area then a bit more work needs to be done. This would be things like: > Determine the number diesel/gasoline vehicles of all types that use I40. Determine length of I40 passing through the study area and calculate fuel used and emissions produced. >Do the same for visitors to the South rim of the Grand Canyon. The number of cars and buses to the Grand Canyon is known and the data must be available somewhere. >Figure the fuel used by the Grand Canyon Rail Road and calculate emissions. Continue to do these types of analysis for any type of emission not covered in the county summaries. This is done to determine if any additional CO, NOx, PM10, PM2.5, SOx, and VOCs need to be added to the totals for the adjusted county summaries. If the county summaries had it all correct in the first place, then the percentage adjusted summaries for all four counties are good to go. The county summaries do not include CO2 emissions, which is a GHG, and was calculated for all aspects of uranium exploration and mining. However, although it would be nice to have the CO2 contributions of all the counties and all the visitors to the Grand Canyon air quality study area, it is quite unnecessary. The Navajo Generating Station provides an overwhelming amount of CO2 to the air quality study area all by itself. From Table 3.2.4 the Navajo Generating Station emits 20.1 million tons per year of CO2. In a 20 year span, this would be 401 million tons of CO2.	The Kayenta Coal Mine as well as any additional PSD sources in the study area has been added to Table 3.2-4. Because the Grand Canyon Railway is not a PSD source its inclusion in Table 3.2-4 would not be appropriate. Emission inventories (Coconino and Mohave Counties, Arizona, and Washington and Kane Counties, Utah) presented in Table 3.2-5 represent air pollutant emissions across all available sources. The emission inventories include, on-road vehicles, non-road equipment, electricity generation, fossil fuel combustion, industrial process, fires, waste disposal, residential wood combustion, solvent use, road dust, fertilizer and livestock and miscellaneous sources. The non-road equipment in this inventory includes gasoline and diesel non-road equipment, such as planes, trains, and ships. According to the 2005 NEI methodology, class I (national), class II (regional), commuter, passenger and yard locomotives are included in the "trains" category. Criteria pollutants were estimated by using locomotive fuel use data obtained from the Department of Energy (DOE) Energy Information Administration (EIA) and available emission factors. Therefore, it is assumed the Grand Canyon Railway and buses to and from the Grand Canyon National Park were included in this inventory. Section 4.2 has been revised to include a discussion of past and present impacts from mining activities. This revision will also include a discussion of the potential

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			The uranium exploration and mining 20 year CO2 emissions were calculated to be 399,100 tons. This is a fractional increase of: 399,100 tons CO2 from U/ 401,000,000 tons CO2 Coal pwr plant = .00099 or 0.1% Given the fact that you could add in the CO2 contributions for all the cities and vehicles in the air quality study area, the additional contribution from Uranium operations is much smaller still. Lets call that negligible. Edit the GHG chatter with a statement that the contribution by Uranium operations is nothing compared to the existing sources in the study area or drop and delete the GHG stuff altogether. Provide a cumulative impact summary that shows the percentage increase for each calculated emission due to uranium operations as compared to current conditions for each alternative.	cumulative impacts from future mining. Moreover, Chapter 3 has been revised to include a discussion of the background levels of air pollutant data, including GHG. When conducting impact modeling with respect to air quality, background concentrations are evaluated in that process. Background emissions are measured concentrations data that includes emissions from all current sources contributing to air quality in the study area including stationary sources, mobile sources, and other use emissions such as cities, power plants, recreational vehicles, livestock grazing, travel on interstate highways, etc.
The NAU Project, LLC	242913	80	Hazardous Air Pollutant Impact Assessment page 4-19 HAPs can cause various adverse health effects. They are not regulated under the NAAQS, but high concentrations at the mine site boundary could indicate the need for further analysis and/or mitigation strategies. NEPA requires YOU to do this!	Text in the EIS in Section 4.2.4 has been revised as follows: "HAPs can cause various adverse health effects. They are not regulated under the NAAQS. However, emission standards for HAPs have been established in regulations contained at 40 CFR 61 and 63. These regulations were established to ensure that HAP emissions do not exceed concentrations determined to be detrimental to human health and the environment." Specific monitoring and mitigation measures to regulate HAPS would be identified and designed in site-specific environmental documentation when a mine is proposed.
Don Lipmanson	96015	1	I know from the posted warning signs that groundwater at Salt Creek cannot be consumed on account of radioactivity from former mining. Likewise, uranium mining in national forests nearby Grand Canyon NP could seriously threaten air safety in the region.	The air quality impact analysis is addressed in the EIS Chapter 4, Section 4.2.
Hualapai Tribe-Office of the Chairman	225270	4	Chapter 3.2.2., Page 3-20. The DEIS should refer to the role of Indian tribal governments in regulating air quality on tribal lands under the Clean Air Act.	Where applicable, each individual mine would be required to seek legal authority to operate; this would include seeking such authority from tribal governments. Under the Clean Air Act, Title V – Permits, some tribal lands have been delegated authority to regulate air quality. In the area of northern Arizona and southern Utah, The Navajo Nation is the only tribal government granted this authority. Other tribal nations in the withdrawal area can participate in permitting activities, but have not been granted the authority regulate air quality. Text has been revised accordingly.
Hualapai Tribe-	225270	28	General Impact Analysis (Flawed Analysis, Missing Info) Appendix B.	The haul trucks are designed such that the material

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Office of the Chairman			Reasonably Foreseeable Development under Alternative B, Table B-19. The Hualapai are greatly concerned about the transportation of uranium ore discussed under the DEIS. The U.S. Department of Transportation's exemption level for uranium is 2.7 x 10-10 Ci/g (see CFR Title 49 Part 173.436) and therefore, uranium ore is regulated as a Class 7 radioactive material under the hazardous material regulations. Under Title 49 Part 173.403, uranium ores and concentrates of uranium ore are classified as Low Specific Activity (LSA), Group - 1 material. Due to low specific activity, ore shipments are generally exempt from most packaging, marking, labeling, and plaque-carding requirements of other Class 7 radioactive materials. In addition to uranium ore, LSA-1 material may also include other low-toxicity alpha emitters that may be shipped from mine to mill such as contaminated soils and rubble. Table B-19 shows that under Alternative B, there would be approximately 276,116 ore tonnage for existing mines within the withdrawal parcels. This equates to 11,045 haul trips for existing mines. New mine hauling trips are estimated at 77,840 trips. The DEIS should include analysis of the level of low-toxicity alpha emitters for all ore tonnage being transported over a twenty year period. Because uranium ore is a Class 7 radioactive material exempt from most of the packaging, marking, labeling and plaque-carding requirements, shipments of uranium ore may be transported without being properly packaged, creating higher levels of radioactive materials and low-toxicity alpha-emitters to be dispersed in dust and wind.	being transported is covered and therefore, emissions from the ore being hauled are controlled/mitigated and not allowed to escape the vehicle as a fugitive source. It is the regulatory agency's responsibility to protect human health and the environment. The site-specific mine plan will include mitigation and control measures for the transportation of uranium ores from the mine site to the processing facility. Language has been added to Section 3.2.2. Legal and Regulatory Requirements, to identify the applicability of 49 CFR Part 171, 172, and 177 to the transport of uranium ore from the mine location to the processing facility. Those regulations were promulgated by the U.S. Department of Transportation and provide the regulatory basis and requirements for such transport. The uranium ore haul trucks in accordance with permit conditions and regulations are covered/sealed within a metal container. According to the Washington State Department of Health, Office of Radiation Protection's - General Radiation Fact Sheets entitled "What is Ionizing Radiation?" (Available at http://www.doh.wa.gov/ehp/rp/factsheets/fsdefault.htm) , uranium ore contains alpha emitters. These alpha particles consist of two neutrons and two protons ejected from the nucleus of an atom. The alpha particle is identical to the nucleus of a helium atom. Examples of alpha emitters are radium, radon, thorium, and uranium. Because alpha particles are charged and relatively heavy, they interact intensely with atoms in materials they encounter, giving up their energy over a very short range. In air, their travel distances are limited to approximately an inch. Alpha particles are easily shielded against and can be stopped by a single sheet of paper. Since alpha particles cannot penetrate the dead layer of the skin, they do not present a hazard from exposure external to the body. Given this lower radioactivity of the uranium ore, the enclosed metal containers in which the ore is transported provides adequate shielding from the ionizing radiation.
U.S. Fish and Wildlife Service	242660	2	For the impact analysis in Chapter 4, the DEIS relies on the assumption that state and Federal regulations have been and are being met in order to minimize environmental impacts to various resources (e.g., air quality on page 4-17, water quality and quantity on page 4-57, Compliance with Environmental Regulations and Pennitting on pages 4-66 to 67). However,	It is outside the scope of this analysis to assume that mining under subsequently issued permits will not be conducted in accordance with applicable law. Furthermore, NEPA does not require the agency to analyze contingencies or worst-case scenarios.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			a recent media report (Arizona Daily Sun, March 11,2011, "Three uranium mines advance") states that Arizona Department of Environmental Quality (ADEQ) did not inspect the currently-operating Arizona 1 mine until it had been open for nine months, and that four "major" violations were not addressed. In addition to testing this assumption, longer-tenn and comprehensive monitoring would also serve to evaluate the potential effects that may result from variations in regulatory compliance.	
Coconino County Board of Supervisors	225238	13	Uranium mining in the withdrawal area requires thousands of haul trips to the mill in Blanding, Utah. There does not appear to be any numerical analysis of the total amount of fugitive dust created through each haul trip, though this certainly could have been done. While it is probably true, as stated on page 4-18 of the DEIS, that "these impacts would be localized and temporary," the cumulative impacts of thousands of trucks could result in very discernible dust clouds, particularly during dry months. It should be noted that the amount of dust created by vehicles increases logarithmically with speed, and there is little or no way to regulate the speed of haul trucks on the unpaved haul routes.	Through a separate, site-specific environmental impact analysis and air quality permitting process, each individual mine would be required to provide appropriate mitigation and control measures to ensure compliance with established emission limitations. The haul trucks are designed such that the material being transported is covered and sealed, therefore, emissions from the ore being hauled are controlled/mitigated and not allowed to escape the vehicle as a fugitive source. Language has been added to Section 3.2.2. Legal and Regulatory Requirements, to identify the applicability of 49 CFR Part 171, 172, and 177 to the transport of uranium ore from the mine location to the processing facility. Those regulations were promulgated by the U.S. Department of Transportation and provide the regulatory basis and requirements for such transport.
Alternatives				
Rita Kester	21356	2	I was hoping that one of the alternatives would be permanent protection but B is a good beginning.	For withdrawals of this size, the Federal Land Policy and Management Act (FLPMA) limits the authority of the Secretary of Interior to withdrawals of 20 years or less subject to valid existing rights. The alternative for a permanent mining withdrawal is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis.
	104132	2	Instead of stopping uranium mining for the next 20 years, put uranium mining to a halt "permanently."	For withdrawals of this size, the Federal Land Policy and Management Act limits the authority of the Secretary of Interior to withdrawals of 20 years or less subject to valid existing rights. The alternative for a permanent mining withdrawal is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis.
Denison Mines Corp	104145	11	However, as an alternative to a withdrawal and to address concerns that have been raised about watershed protection, the BLM and Forest Service could promulgate surface management or other regulations specific to this	The alternative for promulgation of surface management regulations specific to the withdrawal area is discussed in Section 2.3 Alternatives

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			area to provide the desired level of protection. In order to determine to what extent changes to regulations specific to this area may be required, an independent study of the watershed impacts from uranium mining near the Grand Canyon could be completed. The National Research Council of the National Academy of Sciences would be an appropriate entity to complete such a study.	Considered But Eliminated From Detailed Analysis. Study related to such rule making could be conducted regardless of the Secretary's decision on withdrawal.
Gregor Knauer	105023	2	Alternative B is inadequate. The "valid existing rights" of the 4 to 11 mines that are not subject to this withdrawal should be taken back too. Furthermore, 20 years is not long enough! No more uranium mining anywhere anytime.	For withdrawals of this size, the Federal Land Policy and Management Act limits the authority of the Secretary of Interior to withdrawals of 20 years or less subject to valid existing rights. The Mining Law of 1872 confers a property right to claimants determined to hold valid claims. Only Congress has the authority to make a withdrawal without recognizing valid existing rights. The alternative for a permanent mining withdrawal is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis.
Manuel Savala	213919	1	I'm going to propose for the Kaibab Tribal Government another alternative. I already approached BLM ten years ago to give me the Arizona Strip. But I was --well, I went all the way to Phoenix and back. And the final outcome was they told me to go to my Congressman. I wrote my Congressman. I never got anywhere. So, but this time around, since I'm chairman, I'm going to push for another alternative. And I feel that if I got the Arizona Strip we can exert more pressure, maybe not stop the mining, but more additional exploration anyway. But it would benefit the Tribe economically, culturally. Like the Secretary of the Interior said, he wanted to get Indian Tribal Lands under trust. So I want to see if they really want to do that.	The purpose of this EIS it to analyze the impacts of withdrawal of lands from location of new mining claims under the Mining Law of 1872, subject to valid existing rights. Transfer of lands to the Kaibab Paiute Tribe is beyond the scope of this EIS.
DIR Exploration, Inc.	225241	2	The geological data we have brought to your attention in this draft EIS commentary indicate that little or no uranium mining industry or other economic harm would result from the withdrawal of the East (Houserock Valley) Parcel. DIR recommends that the US Department of Interior drop its proposal to withdraw the North and South Parcels of the proposed mining lands withdrawal.	Withdrawal of the East Parcel (Houserock Valley) is covered and analyzed in the current range of alternatives as is the option of not withdrawing the North and South Parcels.
Kanab Utah	225250	8	We are also concerned that the DEIS choose to not consider alternatives that reduced the review period to 5 or 10 years. The justification for doing so was that there would be no changes so there was no need for more frequent review. If you fulfill your responsibility to consider the objectives and plans of other Federal agencies, you will recognize the extremely volatile nature of Utah's energy policy and the impact of international affairs on America's energy supplies. Energy prices impact America's economy which impacts our overall tax base including the funding for agencies such as the Bureau of Land Management and the U.S. Forest Service. Funding limitations have a direct impact on your ability to adequately meet your land management responsibilities. It would be wise	The alternative for a mining withdrawal of less than 20 years is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			to consider shorter term review periods that allow more rapid response to national needs.	
Donald Begalke	225254	4	In Section 2.3.4 *permanent withdrawal at this time*, what the U.S. Public requires as "best protections" for the Grand Canyon itself and the watershed (full complement of areas adjacent to/surrounding the Grand Canyon), is not presented, but "withdrawals made by the Secretary under the authority of FLPMA are renewable .. ". Thus, the above three paragraphs in this comment are reminders that "automatic renewalship" be included as parts of "Alternate B", "Alternate C" and "Alternate D" respectively on Pages 2-2 and 2-3 in this Draft. I respectfully request that the BLM Staff amend each of "B", "C" and "D", using the appropriate language, for "automatic renewalship" of this project being in the Final EIS and being in subsequent withdrawal projects of the future.	The authority of the Secretary of Interior for withdrawing public lands is in Section 204 of the Federal Land Policy and Management Act. There is no legal authority for "automatic" renewal so the option is beyond the scope of this EIS. Withdrawn lands would be analyzed for renewal prior to withdrawal expiration.
National Parks Conservation Association	225257	3	The methodology for determining which areas have higher concentrations of resources that might be impacted is faulty because so much remains to be yet discovered about this vast and largely untraveled area. There has been no complete mapping of the cultural sites, plants, and animals in this watershed. Within Grand Canyon National Park, perhaps, the most-studied area in the western United States, it is widely known within the scientific community that our understanding of the diverse resources it contains is not complete. For instance, last year five new species were discovered in the park - not only new to the park, but new to science as well. Outside the park, where research is less likely to have taken place, the data is even less testable.	Development of alternatives and analysis in the EIS used the best data available including professional scientists from involved Federal agencies (BLM, Forest Service, USFWS, USGS, NPS) and published resources as illustrated in the Literature Cited section of the EIS.
National Parks Conservation Association	225257	4	Was there a reason that an additional alternative expanding the withdrawal area - perhaps to include public lands adjacent to other national parks along the Colorado River - was not included in this effort? It would seem that removing those lands from future uranium mining might also serve the purpose and need expressed in this Environmental Impact Statement, and should be considered (perhaps in a separate process now that this effort will soon reach its natural conclusion).	The withdrawal boundary put forward by the Secretary of Interior is discussed in Sections 1.2 and 1.3. Expanding the boundaries of the withdrawal is beyond the purpose and need for this EIS and is not a reasonable alternative to the proposed action.
Ted Jensen	225282	1	Add an additional alternative to honor existing claims but not allow any further claims. Existing alternatives state they will honor valid existing rights but when you read the fine print, this basically kills all claims given valid claims must have been proven. The alternatives provided do not address the cost to reimburse those negatively impacted with closure action.	The law governing valid existing rights in the mineral withdrawal process is in Section 701 of FLPMA and establishes that withdrawals are subject to "valid existing rights." (A brief discussion of validity can be found in Appendix B, B.8.2) There is no legal authority to reimburse claimants without valid existing rights. Both of these options are outside the scope of the EIS.
Janet Remington	226495	2	From the wording in your draft EIS it is not clear whether all feasible alternatives have been included. For the Grand Canyon and adjoining lands, there should have been an unequivocal no-uranium-mining alternative with no exceptions and a no-mining of any sort alternative for that area.	For withdrawals of this size, the Federal Land Policy and Management Act limits the authority of the Secretary of the Interior to withdrawals of 20 years or less subject to valid existing rights. The Mining Law of 1872 confers a property right to claimants determined

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				to hold valid claims. Only Congress has the authority to make a withdrawal without recognizing valid existing rights. The alternative for a permanent mining withdrawal is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis.
Cody Perry	227663	2	My only suggestion to the proposal would be to make this management decision, instead of 20 years, a decision for all time.	For withdrawals of this size, the FLPMA limits the authority of the Secretary of Interior to withdrawals of 20 years or less subject to valid existing rights. The alternative for a permanent mining withdrawal is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis.
Jannette Huskon	242715	1	We would like to see the Interior Secretary withdrawal for good. If he withdraws it 20 years or longer, she doesn't want to see it.	For withdrawals of this size, the FLPMA limits the authority of the Secretary of Interior to withdrawals of 20 years or less subject to valid existing rights. The alternative for a permanent mining withdrawal is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis.
The NAU Project, LLC	242913	26	Page 2-16 and Figure 2.4-4 The Alternative C for the South Parcel is too restrictive. The area in the Southwest corner of the parcel has the same "values" as the area that is open East of Highway 64 and Red Butte. The area West of Hwy 64 that is only marked "Cultural" should be open for mineral entry under Alternative C. That this area is closer to Havasu Spring should have no bearing as the Water Resource section of this DEIS calculated no or negligible impacts at Havasu Springs from mining development. The Alternative C map should look like: Alternative C is too restrictive for the South Parcel. Both of the areas in the above figure that are now indicated as open are equivalent. There is no reason to remove the West parcel as was done in the current Alternative C. The Alternative C should be changed to reflect the above map or a valid reason not to should be provided. ***see submittal #242913 for detailed figure info**	The area provided in the map by the commenter as recommended for exclusion from Alternative C is currently excluded under both Alternatives A and D and therefore is already included and analyzed in the range of alternatives.
Arizona Geological Survey	225263	3	We propose that at least one additional alternative be included in the EIS that would allow mineral exploration to continue across the area under the existing rigorous standards already in place. Concurrently, additional scientific, technical, and engineering studies would be carried out addressing the topics that are not adequately understood. Exploration companies would have the opportunity to develop the proposed new mining approaches suggested above, through limited prototypes and testbeds, in cooperation with the land management agencies. A full-scale mining operation that went through the permitting process would be as an instrumented, open, proof-of-concept model. Ground and surface waters proximal to the operation would be monitored before, during, and after the prospect is developed. Since the ore deposits are small, a complete mine life cycle could be completed in 3- 5 years, allowing a timely evaluation of	The commenter's suggestion for a new alternative is covered in the FEIS as the No Action Alternative. The "proof of concept model" suggested by the commenter could be implemented for mining operations regardless of the Secretary's decisions on withdrawal. .

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			new techniques. At that time, re-evaluation of impacts could be reassessed and more informed decisions could be made about the long term viability and co-existence of carefully managed and monitored development in this unique and uniquely resource-rich region.	
Coconino County Board of Supervisors	225238	2	At one of the cooperating agency meetings early in the process County staff asked whether one of the considered alternatives could be full withdrawal in one or two of the three areas and partial withdrawal in another area, and that option was rejected. The County presumes that this is due to the methodology used to create the partial withdrawal scenarios, which was dependent on overlays of a number of resources. We acknowledge that the position of Mohave County is different than ours, but also recognize that mining on the west side of Kanab Creek, which is the County boundary, could have impacts on water quality or springs in Kanab Creek or to the Creek itself. Coconino County has supported full withdrawal of the areas within the County, however, there is a possibility that some of the northwest portion of the North Area several miles west of Kanab Creek where there are relatively fewer resources could be left out of the withdrawal area in order to accommodate some level of future mining in addition to just the completion of valid existing claims.	Excluding portions of the northwest area of the North Parcel, as recommended by the commenter, is included in the range of alternatives under Alternatives C and D.
Havasupai Tribal Council	54408	1	If the purpose of the "action" Alternatives B, C, and D is to withdraw geographic areas that encompass particularly sensitive resources, including cultural resources, from the adverse impacts of uranium mining, why has the Traditional Cultural Property ("TCP") of Red Butte not been included in all of the action alternatives? In particular, why was Red Butte included in Alternatives B and C, but not Alternative D? Given the fact that the BLM has a legal obligation under the National Historic Preservation Act and the National Environmental Policy Act to protect TCPs from adverse impact, how would Alternative D provide sufficient protection to Red Butte from the detrimental effects of uranium exploration and mining?	The National Historic Preservation Act (NHPA) requires that TCPs are considered in the decision making for federal actions, but does not necessarily mandate protection from adverse impacts. The EIS complies with the NHPA, but also complies with NEPA by including a full range of alternatives. Concerning Red Butte, the range was analyzed by including it within the withdrawal area in Alternatives B and C, but not within Alternative D. This allows for analysis of impacts of both withdrawal inclusion and exclusion.
Havasupai Tribal Council	54408	3 and 4	The various maps of Alternatives B, C, and D contained within the Draft EIS ("DEIS") illustrate the resources present in each parcel including the hydrologic, cultural, vegetation and wildlife, and visual and recreational resources. Please explain the methodology used to draw the boundaries of the exact locations of these resources. For example, endangered and threaten animal species located within the proposed withdrawal area, like the California condor, Mexican spotted owl, and Black-footed ferret, are mobile and subject to movement from area to are. Similarly, hydrologic resources, such as groundwater, may be expansive and exact locations may be difficult to pinpoint. Given these considerations regarding the difficulty of delineating the exact location of critical resources, how are the boundaries drawn in the DEIS's maps, which classify the resources found in particular areas, accurate? The DEIS discusses the variety of social, cultural and natural resources present in the proposed withdrawal areas. How does the DEIS balance the priority of protection for those various	The alternative development process and methodology is explained in detail in Section 2.2 of the EIS. The factors mentioned in the comment were considered in the development of alternatives and the best available data, along with the input of knowledgeable resource specialists was used to draw the boundaries. NEPA requires analysis of a full range of alternatives and the range presented in the EIS considered resource sensitivity as a factor for developing the range.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			types of resources? For instance, what methodology is used to determine that an area with only cultural resources is less deserving of protection than an area with recreational and hydrologic resources?	
Kaibab Band of Paiute Indians	225255	1	The Kaibab Paiute Tribe requests the Land which was once the Southern Paiute Territory for a thousand years to come back into the Tribe's possession, for tribal self-determination purposes, providing housing, health care and education, which will in turn provide supporting agricultural, energy options and economic development and foremost halt any further new mining development on the Tribes' Mother Earth.	The purpose of this EIS it to analyze the impacts of withdrawal of lands from location of new mining claims under the Mining Law of 1872, subject to valid existing rights. Transfer of lands to the Kaibab Paiute Tribe is beyond the scope of this EIS.
Hopi Tribe	213932	3	we are disappointed that the Bureau of Land Management did not consider our recommendation that an area larger than the Proposed Action be included as an alternative in this DEIS	The withdrawal boundary put forward by the Secretary of Interior is discussed in Sections 1.2 and 1.3. Expanding the boundaries of the withdrawal is beyond the purpose and need for this EIS and it not a reasonable alternative to the proposed action.
Cultural Resources and American Indian Resources				
American Rock Art Research Association	22360	2	This area is rich in cultural resources, including rock art, and has not been yet undergone a complete archaeological survey.	Your concerns have been addressed in the EIS under Section 4.11.2, Compliance with Environmental Regulations and Permitting. All future exploratory projects are required to comply with existing federal laws and regulations implementing the National Historic Preservation Act (NHPA). In compliance with Section 106 of the NHPA, all new exploratory drill projects or new mining projects will undergo a historic property inventory (archaeological survey) in order to ascertain if there are any historic properties (archaeological sites) that are eligible for the National Register of Historic Places (NRHP) that may be within the area of potential effect. If there are any NRHP-eligible properties that will be disturbed by the proposed project then avoidance or mitigation to reduce any adverse effects will be required.
Glendora Homer	54359	1	The aboriginal cultural resources of the Kaibab Paiute Tribe would be greatly affected. Within the proposed north parcel withdrawal area is the 1. Kanre'uipi (Kanab Creek) ecoscape, 2. Wa'akarerempa (yellow water) known as yellowstone springs, 3. Tinkanivac (cave water) known as antelope or moonshine spring, 4. aboriginal trails from cave water spring (Tinkanivac) to the Colorado River, 5. trails along Kanab Creek (Kanre'uipi) to the Toroweep cultural site, 6. traditional subsistence trails for hunting and gathering, 7. important cultural sites within the Kanab Creek, 8.	Thank you for your description of areas important to the Kaibab Paiute Tribe. Analysis of the impacts to these resources has been addressed in the EIS under Section 4.12, American Indian Resources.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			important mineral deposit, 9. culturally important spiritual trail within Kanab Creek to the Colorado River.	
Lawrence McTigue	94040	2	(Page ES-8) Cultural Resources (National Register of Historic Places) 1,981 sites have not yet been evaluated with respect to NRHP eligibility status. Comment: If nearly 2,000 sites (still) have not been evaluated yet, then that (in and of itself), is sufficient reason (not) to allow any mining, to take place, until all those sites (have) been evaluated.	Your concerns have been addressed in the EIS under Section 4.11.2, Compliance with Environmental Regulations and Permitting. All future exploratory projects are required to comply with existing federal laws and regulations implementing NHPA. In compliance with Section 106 of the NHPA, all new exploratory drill projects or new mining projects will undergo a historic property inventory to identify and evaluate any historic properties (archaeological sites) that may be eligible for the NRHP and may be affected. If the survey and evaluation determines that NRHP-eligible historic or archaeological sites will be affected by the proposed project then avoidance or mitigation to reduce any adverse effects will be required.
American Clean Energy Resources Trust (ACERT)	225256	40	Page 3-204 Statement: *Because Class III (on-the-ground, intensive) surveys are required prior to authorizing specific surface-disturbing activity, the number of known significant sites is likely to increase over time.* Comment: Yes, as a result of the extensive mine permitting process (which includes an archeological survey as part of any required EIS), numerous artifact sites have already been identified, studied and items recovered. This is one direct result and benefit of mining activities in the area. Without such mining activities, intensive on-the-ground surveys are highly unlikely to occur. Archeological surveys are not high on anyone's budget.	Thank you for your comment. Thank you for your comment.
American Clean Energy Resources Trust (ACERT)	225256	41	Page 3·204 Statement: *Approximately one-third of the sites cannot be reliably assigned to a specific cultural tradition or time period. They consist largely of prehistoric or American Indian artifact scatters that lack pottery or other datable items. These sites resulted from temporary use of dispersed locations for traveling, short-term shelter, and collecting natural resources for food, medicine, and production of tools and other items.* Comment: While prehistoric or Native American artifact "scatters" resulting from "temporary use" (which lack pottery or other such datable items) can provide some information about the scope of historical human use of the land, such sites neither offer much specific information nor provide any major breakthroughs in interpreting the archeological or historical record. That archeological "scatters" remain where a prehistoric native once stopped at a location to chip a flint arrowhead, build a fire or butcher a carcass only underscores the fact that the vast majority of the land in question was only used temporarily while transiting the area and for short-term occupation.	The NHPA sets forth legal procedures intended to initiate expert evaluation of any site that may be eligible for listing on the NRHP including temporary use sites. The long history of use of the proposed withdrawal area by American Indians is detailed in the EIS under Appendix I, Cultural History of the Proposed Withdrawal Area. While many sites throughout the proposed withdrawal area are temporary use sites, there are also hundreds of long-term habitation sites including pueblos and other villages, as well as farming sites. Please see pages I-6 through I-19 for descriptions of several American Indian groups with permanent or semi-permanent occupation sites in proposed withdrawal area.
American Clean	225256	42	Page 3-206 Statement: *American Indians in the Southwest have an*	Clarification of the term "Grand Canyon area" has been

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Energy Resources Trust (ACERT)			*intimate relationship with the landscape, especially that of the Grand Canyon area (Fairley 2004; Hirst 2006; Stoffle et al.2005).*Comment: While the phrase "Grand Canyon area" is constantly employed and referenced in this section of the DEIS, the boundaries of the "Grand Canyon area" area are never definitively defined. This DEIS implies that the "Grand Canyon area" includes all areas of the proposed withdrawal. What is the criteria used for this piece of semantic hocus-pocus? The "Grand Canyon area" might. in fact be severely limited in scope to the immediate canyon itself or, conversely, might include a far larger area extending as far west as Las Vegas, east to the Four Comers area, north to Moab and south to Flagstaff. Which is it?	added to Section 3.12.1 of the FEIS. The term "Grand Canyon area" encompasses the Grand Canyon, the proposed withdrawal area, and the immediately surrounding lands.
American Clean Energy Resources Trust (ACERT)	225256	43	Page 3-206 Statement: *There are currently no NRHP-listed TCPs associated with American Indian cultures within the proposed withdrawal parcels.* Comment: No matter what additional caveats may be added to this statement, the fact remains that there are currently no NRHP-listed TCPs in the proposed withdrawal areas. Again, extraneous information included at great cost.	The types of American Indian resources that are considered as part of this analysis are given in Section 3.12.1, Traditional Cultural Values and Practices. In compliance of Section 106 of the NRHP, the BLM must consider the effects of its actions on places of traditional cultural importance, including TCPs, that may be or have been determined eligible for the NRHP, not only those that are listed. Red Butte has been determined eligible as a TCP by the Forest Service. This information has been added to the FEIS in Section 3.12.2, American Indian Use Areas.
American Clean Energy Resources Trust (ACERT)	225256	44	Pages 3-206 through 209 Statement: *All sections pertaining to the Southern Paiute, Havasupai Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe and Pueblo of Zuni origin legends, stories, myths and "traditional" lands.* Comment: While relating the various tribes' creation myths and stories, sacred deities and association with the lands they have inhabited through history is interesting, it fails to mention the historical movement of these people due to climatic change, warfare, disease and other factors. To include the Hopi who "currently do not live near the Grand Canyon [as] the origin place of their people ... they see themselves as stewards of the earth, including the Grand Canyon and the proposed withdrawal area" is, at best, disingenuous and misleading. Should Mexico have a say about what happens in those areas of the United States that were once a part of Mexico but which were lost through war? Constant mention in this section of the DEIS that, in essence, "the Grand Canyon and the surrounding areas is entirely sacred" to various tribes and tribal members may be true, however, Executive Order 13007 of 1996 severely limits the meaning of "sacred site" to a "specific, discrete, narrowly delineated location on Federal land" that a practitioner has identified to an agency as having "established religious significance."	The Hopi are one of several tribes with historic and current ties to the proposed withdrawal area. Many tribal members continue to visit the proposed withdrawal area to visit culturally important places. A brief account of Hopi history can be found in Appendix I under Section I.5.4, Hopi. EO13007 is only one of several legal requirements that the BLM may, if applicable, consider when evaluating a proposed action. These laws, regulations, and policies require the BLM to consider the effects of proposed actions on properties of traditional religious and cultural importance to an Indian tribe which may be determined to be eligible for inclusion on the National Register, and to consult with any Indian tribe that attaches religious and cultural significance to such properties. These properties may include, but are not limited to sacred sites.
American Clean Energy Resources Trust	225256	45	Pages 3-209 Statement: *Most American Indians prefer that archaeological sites not be disturbed and that access to them be limited in order to prevent vandalism.* Comment: Vandalism of archaeological sites was	As stated in Section 1.5.3, Issues Eliminated from Detailed Analysis of the EIS, potential vandalism was not considered in the analysis of the alternatives. It is

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
(ACERT)			supposedly one of numerous matters placed beyond the scope of the EIS per section 1.5.3 (Issues Eliminated from Detailed Analysis) which specifically states: "The following issues have been eliminated from detailed analysis because they are beyond the scope of the DEIS. Illegal activities such as poaching, vandalism, and unauthorized collection of cultural artifacts, or unauthorized OHV travel; these are law enforcement issues" (emphasis added). To address anything specifically placed beyond the scope of the DEIS is hypocritical, disingenuous, two-faced and makes the validity and fairness of the entire report more than questionable. Is something that is supposedly "beyond the scope" only used when it conveniently suits predetermined conclusions? This seems to be the criteria used in this instance and in many other places within this DEIS	possible that in some cases the proximity of an archaeological site to development could increase the potential for vandalism; however, such vulnerability would depend upon several factors including the site's size and visibility. Such potential indirect effects would be analyzed as part of Section 106 compliance for specific mining proposals. Further, this statement is made in the context of American Indian preference rather than EIS analysis.
American Clean Energy Resources Trust (ACERT)	225256	46	Pages 3-209 through 213 Statement(s): Numerous and varied statements and phrases referring to American Indian: *"traditional cultural landscape(s)," traditional use areas," "water connection places," "places used for traditional hunting and gathering," "traditional seasonal movement(s)," "indivisible Traditional Cultural Property," "temporary camps," areas used "to gather plant resources and to hunt animals," "economic/subsistence resource areas," "travel corridors," "seasonal camps," et cetera, et cetera, et cetera, ad nauseam. "When dealing with cultural landscapes and places, the analysis of possible impacts is dependent on the emotional and intellectual response of the concerned groups and individuals. It is, in essence, their reaction and opinions alone that determine whether there is an impact and the relative significance of that impact."* Comment: The idea implied here that any 21st century activity whatsoever occurring anywhere within the "American Indian Use Areas" in northern Arizona (as described in these sections of the DEIS) will somehow degrade the spiritual or emotional experience or response of various tribes and/or tribal members and/or may be offensive to the feelings of tribes and/or tribal members about their religion, culture or heritage and may somehow decrease the spiritual fulfillment obtained from the practice of their religion or cultural heritage is blatantly absurd, ridiculous and asinine. Any spiritual or cultural experience, any emotional response to a "cultural landscape" is, at best, highly individual and highly subjective. First, with the sole exception of well-defined sites containing substantially important historical archeological resources such as pictographs, rock paintings and the ruins of dwellings, the overwhelmingly vast majority of the area in question was used sporadically, seasonally, temporarily and for transit purposes. Period. Second, if "sacred sites" do exist in the area, Executive Order 13007 of 1996 clearly limits the meaning of "sacred site" to a "specific, discrete, narrowly delineated location on Federal land" that a practitioner has identified to an agency as having "established religious significance." Third, any government action (such as allowing continued mining in northern Arizona) that (to practitioners of a religion or members of a culture) decreases the spirituality, the fervor, or	EO13007 is only one of several legal requirements that the BLM may, if applicable, consider when evaluating a proposed action. These laws, regulations, and policies require the BLM to consider the effects of proposed actions on properties of traditional religious and cultural importance to an Indian tribe which may be determined to be eligible for inclusion on the National Register, and to consult with any Indian tribe that attaches religious and cultural significance to such properties. These properties may include, but are not limited to sacred sites.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the satisfaction with which a believer practices his religion and/or culture is not what Congress has labeled a "substantial burden" on the free exercise of religion. In allowing mining, the government would not be coercing the tribes or tribal members to act contrary to their religious beliefs under the threat of sanctions, or conditioned a governmental benefit upon conduct that would violate their religious beliefs; therefore, there would be no "substantial burden" on the exercise of their religion or, by extension, their cultural heritage. Were it otherwise, any action the federal government was to take, including action on its own land, would be subject to the personalized oversight of millions and millions of citizens. Each citizen would hold an individual veto to prohibit the government action solely because it offends his religious beliefs, sensibilities, tastes, or fails to satisfy his religious or cultural desires. Further, giving anyone religious sect or cultural entity a veto over the use of public lands would deprive others of the right to use and benefit from what is, by definition, land that belongs to everyone.	
American Clean Energy Resources Trust (ACERT)	225256	47	Page 3-211 Statement: *Although not specifically mentioned in the literature, access routes to culturally significant places south of the parcel must also be considered. Modern access is via roads; however, the existence of trails to this area must be assumed. During consultation, the Hopi Tribe indicated that several places north of the Grand Canyon, including Mt Trumbull, have traditional cultural importance. The Hopi travel through the North and East parcels to reach places of ritual importance north of the Grand Canyon.* Comment: To assume that in the existence of trails to various culturally significant places anywhere and to imply that such trails somehow need protection is blatantly absurd. As noted in this section, "modem access is via roads ... " In the 21st century, to envision any tribal member slogging on foot for miles along a trail in the middle of summer (or any other time of year) to visit a "culturally Significant" or "sacred" tribal locale is both unreal and ludicrous. While tribal members may profess a strong connection to ancient religious beliefs, customs, locales and "landscapes," they would most likely visit any such places using a modem vehicle driving on an access road. This fact alone would cause many to question their level of commitment to "ancient ways."	The FEIS documents the information available to BLM through Tribal consultation or otherwise, and analyzed for purposes of the EIS. Clarification of this issue has been added to Section 3.12.2 American Indian Use Areas of the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	48	Page 3-213 Statement(s): *Resource condition indicators for cultural landscapes and places are not easily definable or quantifiable. The importance of landscapes and places can be understood through a group or individual's "sense of place." Sense of place refers to how people experience and understand a location; the experience and understanding are a product of one's cultural history and values, such that different groups can experience the same place in different ways (Allen et at 2009; Farnum et al. 2005). Sense of place is tied to group and individual emotions and backgrounds, making it difficult to define and even harder to quantify. When dealing with cultural landscapes and places, the analysis of*	EO13007 is only one of several legal requirements that the BLM may, if applicable, consider when evaluating a proposed action. These laws, regulations, and policies require the BLM to consider the effects of proposed actions on properties of traditional religious and cultural importance to an Indian tribe which may be determined to be eligible for inclusion on the National Register, and to consult with any Indian tribe that attaches religious and cultural significance to such properties. These properties may include, but are not

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			possible impacts is dependent on the emotional and intellectual response of the concerned groups and individuals. It is, in essence, their reaction and opinions alone that detennine whether there is an impact and the relative Significance of that impact. Comment: So, cultural landscapes and places that are neither easily definable nor quantifiable, are more tied to individuals emotions and opinions, are difficult to define and even harder to quantify and the impact and the relative significance of such impact is solely dependent upon individual reaction and opinion? An individual veto to prohibit any government action on its own land solely because it offends one individual's religious beliefs, sensibilities, tastes, or fails to satiSfy his religious or cultural desires is not what is intended by any known federal law. Again, Executive Order 13007 of 1996 clearly limits the meaning of "sacred site" to a "specific, discrete, narrowlv delineated location on Federal land" that a practitioner has identified to an agency as having "established religious significance." Any government action (such as allowing continued mining in northern Arizona) that somehow decreases the spirituality, the fervor, or the satisfaction with which a believer practices his religion and/or culture is not what Congress has labeled a "substantial burden" on the free exercise of religion. For example, in allowing mining, the government would not be coercing the tribes or tribal members to act contrary to their religious beliefs under the threat of sanctions, or conditioned a governmental benefit upon conduct that would violate their religious beliefs; therefore, there would be no "substantial burden" on the exercise of their religion or, by extension, their cultural heritage. Were it otherwise, any action the federal government was to take, including action on its own land, would be subject to the personalized oversight of millions and millions of citizens. Each citizen would hold an individual veto to prohibit the government action solely because it offends his religious beliefs, sensibilities, tastes, or fails to satisfy his religious or cultural desires. Further, giving anyone religious sect or cultural entity (or any individual member of such) a veto over the use of public lands would deprive others of the right to use and benefit from what is, by definition, land that belongs to everyone.	limited to sacred sites.
American Clean Energy Resources Trust (ACERT)	225256	103	Pages 4-201 to 4-208 Page 2-41, Table 2.8-1 *Statement: Entire Section* Comment: Cultural resources are directly impacted primarily by either physical disturbance or "from effects on one or more aspects of integrity (location, design, setting, materials, workmanship, feeling, and association), which would disturb the character of the setting." Indirect impacts result from "loss of opportunities for interpretive development or educational uses." Since cultural resources are location specific and the mine locations are unknown at this time the DEIS "assumes that all future mining-related activities have the potential to affect any of the resources." 1. Under Alternative A there are 2,655 "known" sites within the land slated for withdrawal, including those that are ineligible and unevaluated for inclusion in the National Register of Historic Places (NRHP). Only 12 of	Section 4.11 of the EIS analyzes the predicted impacts to the resources by alternative so that the Secretary of the Interior can make an informed decision. The potential impacts from other types of projects on the proposed withdrawal are discussed in Section 4.11.4, Alternative A: No Action, Cumulative Impacts.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			these are actually listed (Table 4.11 -3, page 4- 204). 2. Each new "mine development would be subjected to intensive archeological surveys to identify and evaluate cultural resources that could be affected. Impacts to cultural resources would be considered and addressed through the NEPA and Section 106 processes, with efforts made to identify, avoid, mitigate, or otherwise resolve any adverse effects" (page 4-202). Further, "no cumulative impacts to cultural resources are anticipated under Alternative A" (page 4-205). 3. In view of the above what would be the justification of removing 1 + million acres from mining as suggested in Alternative B, or even the smaller amounts of land under Alternatives C and D? It should be borne in mind that there will also be impacts on cultural resources due to a number of other construction projects, cattle grazing, nonlocatable mineral mining, fire management procedures, natural wildfires, and the like.	
American Clean Energy Resources Trust (ACERT)	225256	104	Pages 4-208 to 4-215 Pages 2-41 and 2-42, Table 2.8-1 Comment: According to the DEIS "American Indian resources consist of many types of places and landscapes, including tribal homelands, places of traditional importance, traditional use areas, cultural landscapes, trails, springs and waterways, and sacred sites." These facilitate to sustain the culture, that is, "cultural heritage, respect for ancestors, spirituality, education, economics, and social relationships." Potential impacts are evaluated based on "documented ethnographic resources." However, these reports are not comprehensive "because many tribes feel that they should not share sacred and tribal knowledge with outsiders." This implies that "any mining activity has the potential to affect yet-unidentified resources." 1. "Many American Indians view exploratory drilling and mining as wounding the earth." No specific tribes are mentioned, except the Hopi. Yet many Hopi were working at the Black Mesa coal mine while it was operating, and presumably some are still working at the Kayenta mine (along with the Navajo) . How do they square this with their beliefs? 2. Almost all the tribes (including the Hopi) around the withdrawal area have agricultural activities within their homelands and elsewhere. For this they must plow the land. Is this not wounding the earth? Are the water wells that they drill for tribal consumption and agricultural irrigation not considered to wound the earth? 3. The Hualapai have built the Skywalk over the Grand Canyon, and plan to build a highend resort, golf course, campgrounds and other facilities as tourist attractions. The Navajo are planning a casino and a coal-burning power plant, although the Navajo Cultural Landscape encompasses the entire Coconino Plateau. How do all of these construction projects integrate into the cultural landscapes around their homelands? 5. It is worthy of emphasizing that each new mine would be the subject of its own sitespecific EIS and the NEPA process. This discussion could be extended, but some of these issues need to be resolved or explained satisfactorily	The purpose of the EIS is to analyze the effects of the proposed action and alternatives. Analysis of actions outside the proposed withdrawal boundaries are out of scope of the EIS.
American Clean	225256	104	4. "Draft versions of all relevant documents such as archeological and	BLM is required to conduct government to government

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Energy Resources Trust (ACERT)			ethnographic studies and draft EAs and EISs are provided for review by tribal members." Evidently this DEIS has also been reviewed by them earlier and the tribes have the further opportunity to comment during this period.	consultation with Indian tribes as part of NEPA and Section 106 compliance. This consultation must be initiated early in the process. It is necessary to share substantive information as part of this consultation. In addition, tribes that elected to participate as formal cooperating agencies, like all of the other cooperating agencies, were provided the opportunity to review preliminary draft versions of the EIS.
American Clean Energy Resources Trust (ACERT)	225256	130	APPENDIX H - CULTURE HISTORY OF THE PROPOSED WITHDRAWAL AREA Statement: All Pages Comment: In this unnecessary fifty-pius page expose, the writer failed to mention that the entire area north of the Grand Canyon was completely abandoned by Native Americans several times and, once for at least 100 years due to severe drought. It was and remains a desert.	The FEIS Appendix I, Section I.1, Prehistoric and Historic Cultural Chronology, has been revised to provide further explanation about the history of occupation by American Indians Tribes and their ancestors in the withdrawal area. These lifeways are also described in Appendix I of the FEIS under Section I.4.1 Virgin Anasazi, Section I.4.2 Kayenta Tradition, and Section I.5.2, Southern Paiute.
American Clean Energy Resources Trust (ACERT)	225256	131	*And Class I Cultural Resources Overview for the Northern Arizona Proposed Withdrawal on the Bureau of Land Management Arizona Strip District and the Kaibab National Forest, Arizona (221 pages) - released AFTER the DEIS All Statements, Information, Conclusions, History, et cetera* Comment: In total, these two separate documents babble on ad nauseam for a total of over 250 pages, predominantly about the pre-Columbian history of various tribal units who, on occasion, used the area. Never once in all these pages is it ever mentioned that the entire area has (during the course of human history in the Americas) been completely abandoned for various lengths of time by all people. Northern Arizona was primarily a desert in the past and it remains one. These pages fail to even hint (much less specifically mention) that the major reason occupation of the northern Arizona area changed from one tribal group to another is because of belligerence, hostilities and open warfare stemming from the fierce competition for the extremely limited resources the area was seasonally able to provide. Nowhere in all of this prose was it ever pointedly stated that the Native Americans who wandered northern Arizona were hunter-gatherers almost constantly on the move and only stopping at any single location for as long as it took them to obtain what they specifically came for and exhaust other local resources.	The FEIS, Appendix I, Section I.1, Prehistoric and Historic Cultural Chronology, has been revised to provide further explanation about the history of occupation by American Indians Tribes and their ancestors in the withdrawal area. These lifeways are also described in Appendix I of the FEIS under Section I.4.1 Virgin Anasazi, Section I.4.2 Kayenta Tradition, and Section I.5.2, Southern Paiute.
American Clean Energy Resources Trust (ACERT)	225256	132	*ADDENDUM - ADDED AFTER DEIS AND POSTED ON BLM WEBSITE Class I Cultural Resources Overview for the Northern Arizona Proposed Withdrawal on the Bureau of Land Management Arizona Strip District and the Kaibab National Forest, Arizona (221 pages) - released AFTER the DEIS Page 135: Kanab Creek Ghost Dance Site Statement: The Kaibab Paiute have identified one panel of white figures as being associated with the Ghost Dance ceremony, which was perfonned in the late nineteenth century (Stoffle et al. 2000). The Ghost Dance was a significant*	Not a substantive comment. No response required.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			revitalization movement that began among the Paiute in Nevada but quickly spread throughout the tribes in Northern Arizona, Utah, and into the Great Plains (Kehoe 1989). Comment: A "revitalization movement?" What fails to be explained is that the Ghost Dance's precursor (the Circle Dance) had other historical significance which was changed and then promoted by the prophet Jack Wilson's teachings which prophesied a peaceful end to white American expansion while preaching goals of clean living, honest life and cross-cultural cooperation. As the ritual spread from its original source (and its original significance changed), other Native American tribes synthesized selective aspects of the ritual with their own beliefs including the development of Ghost Shirts which warriors could wear to spiritually repel the white man's bullets. The Ghost Dance and the subsequent Ghost Shirts culminated in disastrous consequences for the Lakota Sioux in the Wounded Knee Massacre of 1890 and other smaller and lesser know encounters prior to that time. It doesn't seem like something to rejoice in, preserve and exult except for those who would celebrate other such similar human tragedies.	
Energy Fuels Resources	225260	7	I disagree with the assessment that "major direct impacts" would occur to cultural resources if avoidance is not possible. This assessment is incorrect, the statement "if avoidance is not possible" is flawed because current federal laws would not allow destruction of cultural resources. In addition, there is no mention of "major direct impacts" in Section 4.11 of the DEIS, which provides details of the cultural resource analysis. Furthermore, as discussed in Sections 4.11.1 and 4.11.2 of the document, existing mining regulations address cultural resource disturbance through avoidance and mitigation.	Current federal laws do allow for the destruction of a resource. Under Section 106 of the NHPA, adverse impacts to historic properties (archaeological sites and historic structures) can be reduced through mitigation by data recovery, which itself often destroys the site; however, in some cases mitigation of all adverse effects is not possible due to the nature of a project or the resources.
Energy Fuels Resources	225260	8	I disagree that a "major long-term direct impact" would occur to American Indian resources under any of the proposed alternatives. Section 4.11 discusses risk to impacting American Indian resources in a qualitative manner and also discusses mitigation measures; however, the section does not predict major long-term impacts for any of the alternatives. Therefore, the executive summary needs to be corrected.	Impacts to American Indian resources are discussed in Section 4.12 of the EIS. Some types of American Indian resources, such as traditional cultural places, can be extremely, culturally sensitive and disturbance to these areas could have the potential to cause harm to modern day tribal cultures; therefore, disturbance to these places is permanent and irreversible and considered a major long-term direct impact.
Uranium Watch	225262	78	Section 4.11 Cultural Resources. Pages 4-201 to 4-208. This section fails to identify and assess the impacts to cultural resources of the processing of uranium ore from the withdrawal area at the White Mesa Uranium Mill. The expansion in the number of potential uranium mines in the area will result in the processing of additional ore at the Mill. This will require the construction of new tailings impoundments at the Mill. The construction of new tailings cells will, as in the past, result in the destruction of large and unique cultural resources—ancient pit houses and burial sites. The destruction of these pit houses is a direct result of the expansion of uranium mining on federal lands in Utah and Arizona. The DEIS must	An archeological report was developed as part of the environmental report required by the State of Utah for licensing of the White Mesa Mill. Since the mill is expected to remain within the existing permitted capacity under all of the alternatives analyzed in this EIS, operations at the mill are not considered a connected action to the proposed withdrawal, so are beyond the scope of this EIS. Any proposed expansion of the Mill onto federal lands would require a survey, evaluation, and resolution of any adverse effects in

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			consider the impacts to the significant cultural resources on White Mesa in the assessment of the impacts to cultural resources from the various alternatives. Information regarding past impacts to the cultural resources can be found on the Uranium Watch website10, the Utah Division of Radiation Control website11, and the Grand Junction Office of the U.S. Department of Energy12.	compliance with Section 106 of the NRHP and environmental documentation in compliance with NEPA.
Uranium Watch	225262	79	Section 4.11 Cultural Resources. Pages 4-201 to 4-208. Further, the operation of the Mill has the potential to impact cultural resources on land that is part of the Mill that was obtained from the BLM. The BLM's Monticello, Utah, Office retained responsibility for the preservation of the cultural resources on that land.	An archeological report was developed as part of the environmental report required by the State of Utah for licensing of the White Mesa Mill. Since the mill is expected to remain within the existing permitted capacity under all of the alternatives analyzed in this EIS, operations at the mill are not considered a connected action to the proposed withdrawal, so are beyond the scope of this EIS. Any proposed expansion of the Mill onto federal lands would require a survey, evaluation, and resolution of any adverse effects in compliance with Section 106 of the NRHP and environmental documentation in compliance with NEPA.
Uranium Watch	225262	81	Section 4.12 American Indian Resources. Page 4-208 to 4-215 The DEIS must evaluate the impacts to resources of the Westwater Navajo community in the vicinity of the White Mesa Mill and nearby Blanding, Utah.	An archeological report was developed as part of the environmental report required by the State of Utah for licensing of the White Mesa Mill. Since the mill is expected to remain within the existing permitted capacity under all of the alternatives analyzed in this EIS, operations at the mill are not considered a connected action to the proposed withdrawal, so are beyond the scope of this EIS. Any proposed expansion of the Mill onto federal lands would require a survey, evaluation, and resolution of any adverse effects in compliance with Section 106 of the NRHP and environmental documentation in compliance with NEPA.
Uranium Watch	225262	80	Section 4.11 Cultural Resources. Pages 4-201 to 4-208. The DEIS must evaluate the impacts to the resources of the Ute Mountain Ute Tribal community on White Mesa. White Mesa Band land is adjacent to the White Mesa Mill. The Mill impacts their land, resources, and cultural values. The people at White Mesa complain constantly of the smell of the Mill; the Mill exposes tribal members to the radioactive and non-radioactive hazardous materials; the Mill impacts the tribe's ability to make use of traditional animal and plant resources; the Mill has the potential to impact their water resources; and the Mill adversely impacts the cultural values of the tribal members.	An archeological report was developed as part of the environmental report required by the State of Utah for licensing of the White Mesa Mill. Since the mill is expected to remain within the existing permitted capacity under all of the alternatives analyzed in this EIS, operations at the mill are not considered a connected action to the proposed withdrawal, so are beyond the scope of this EIS. Any proposed expansion of the Mill onto federal lands would require a survey, evaluation, and resolution of any adverse effects in compliance with Section 106 of the NRHP and environmental documentation in compliance with

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				NEPA.
Uranium Watch	225262	82	The DEIS must evaluate the impacts of transportation of ore from the uranium mine sites in the withdrawal area to the White Mesa Mill on tribal resources in Arizona and Utah.	Within Section 4.12, American Indian Resources, the EIS analyzes the effects of transporting uranium within the proposed withdrawal area by using the scenario for new road creation under each alternative presented in the RFD (Appendix B, Locatable Mineral Resources - Reasonably Foreseeable Development Scenarios). Analysis of the impacts of ore transportation outside of the proposed withdrawal area is addressed in EIS in Section 4.16, Social Conditions, and Sections 4.2.5-4.2.8, Air Quality and Climate.
Uranium Watch	225262	94	The EIS cannot separate the impacts of uranium mining in the withdrawal area from the impacts of the processing of that ore at the Mill. For some reason the USFS did not see fit to consult with the Ute Mountain Ute Tribe. This was a grave oversight.	An environmental report required by the State of Utah for licensing of the White Mesa Mill. Since the mill is expected to remain within the existing permitted capacity under all of the alternatives analyzed in this EIS, operations at the mill are not considered a connected action to the proposed withdrawal, so are beyond the scope of this EIS. Any proposed expansion of the Mill onto federal lands would require a survey, evaluation, and resolution of any adverse effects in compliance with Section 106 of the NRHP and environmental documentation in compliance with NEPA.
National Trust for Historic Preservation	225277	2	The Draft EIS outlines several particular sites that would be vulnerable to damage if hardrock mining were permitted in the project area. While not yet formally evaluated for its significance, the Kanab Creek Ecoscape on the North Parcel contains an ancient traderoute and is considered an integral part of the Grand Canyon TCP by the Southern Paiute Consortium. (Draft EIS at 3-210). Three mines are already proposed within this Ecoscape and, presumably, more resource exploitation would occur in the event these lands were opened for future claims.	Potential impacts to American Indian resources in the Kanab Creek area are described in Section 4.12, American Indian Resources. All withdrawal alternatives (B, C, and D) incorporate this area.
Ted Jensen	225282	9	Section regarding Impacts on Culture Resources includes misleading "if" statement (page ES-13). It states if direct mitigation is not possible then the summary rating becomes very bad. This actually implies there will be no control and existing laws will be broken and mining controls will be nonexistent.	Under Section 106 of the NRHP, adverse impacts to historic properties (archaeological sites and historic resources) can be reduced through mitigation which itself often destroys the site; however, in some cases mitigation is not possible due to the nature of a project or the resources.
Ted Jensen	225282	10	On page executive summary (page ES-13) describes a disturbance to a Traditional Cultural Place will occur. What does this mean and where is this place? I looked and could not find it in the body of the report. Why is Traditional Cultural Place capitalized for emphasis or is it a formal name? If an emphasis, why?	Discussion of the definition of a TCP can be found in Section 3.12.1, Traditional Cultural Values and Practices, of the EIS. Red Butte has now been determined eligible for the NRHP as a TCP. Discussion of Red Butte as a TCP has been expanded in Section 3.12.2, American Indian Use Areas, of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Potential impacts to Red Butte are discussed in the EIS under Section 4.12.4 through 4.12.7.
Maren Mahoney	226214	2	1. The EIS failed to adequately consider the cumulative impacts on Cultural Resources under all the Alternatives if direct impact mitigation (complete avoidance) is not possible. The EIS provides that there are numerous unique, fragile, finite and nonrenewable cultural resources within all three of the proposed withdrawal parcels. It will be impossible to completely avoid all cultural resources if, say, Alternative A is chosen. Yet there is no discussion or analysis of the cumulative impact that will inevitably occur.	Section 106 of the NRHP requires mitigation of adverse impacts to cultural resources. Avoidance is the preferred method of mitigation, but others such as data recovery can also be used when avoidance is not possible. The Cumulative Impacts analysis is in EIS Sections 4.11.4 through 4.11.7. Since the locations of future mines are unknown, the cultural resources that might be affected are also unknown. Analysis of cumulative effects to cultural resources would be conducted in greater detail as part of Section 106 compliance for specific mining proposals.
VANE Minerals	242650	4	The DEIS conclusions contain contradictions and flawed reasoning. For example, on page ES-13 of the Executive Summary under the Impacts on Cultural Resources, the following statements are made: *1) Under all alternatives, there would be no direct impacts to the disturbance of historic and prehistoric sites, assuming that direct impacts on sites by individual projects are mitigated through established regulations and policies. 2) "If direct impact mitigation were not possible, Alternative A would have a major direct impact...*11 In Statement 1 above, the inclusion of the word "assuming" is unnecessary because all exploration and mining activities are regulated. Statement 2 implies "major direct impact" would happen if no mitigation measures were taken and established regulations and policies were violated in lill cases. These are frantic assumptions.	Under Section 106 of the NRHP, adverse impacts to historic properties (archaeological sites and historic resources) can be reduced through mitigation such as data recovery which itself destroys the site; however, in some cases mitigation is not possible due to the nature of a project or the resources. Some impacts, such as those that affect a particular setting, cannot be mitigated. Language has been added to the Cultural Resources section of the Executive Summary of the FEIS to clarify the potential impacts of the alternatives.
VANE Minerals	242650	5	With respect to Impacts on American Indian Resources, page ES-13, the DEIS states: *1) There are no tribal trust resources or assets within the proposed withdrawal area. 2) Alternative A will have major long-term impact on resources on all three parcels, including disturbance to a Traditional Cultural Place ...* Statement 1 above directly contradicts statement 2. Statement one states there are no resources while statement two describes major long-term impacts to resources. With all due respect, the BLM's "multiple use" mandate should not prohibit one user at the benefit of another. Using this as a basis for the withdrawal will be in direct violation of that mandate. Further to this, the DEIS clearly describes reclamation and implies short-term use and impact. Statement 2, in using "major long-term", contradicts this.	The referenced Traditional Cultural Place (TCP) is Red Butte, which is located in the South Parcel; a TCP is not a tribal trust resource or asset. A clarification of the terms "tribal trust resources or assets" has been added to the FEIS in Section 3.12.2, American Indian Use Areas. Resources and values of concern to Indian tribes may include but are not limited to trust assets. In addition, Sections 3.11, 3.12, 4.11 and 4.12 have been revised to use consistent terms that more closely track and explain legal requirements under applicable legal authorities.
The NAU Project, LLC	242913	16	Impacts on Cultural Resources The last line in this paragraph should have added to it -- if exploration and mining were to occur near them. If no operations were performed near a cultural site, it would be difficult to contend that there were auditory or visual impacts on those sites.	The language has been added to Impacts on Cultural Resources section of the Executive Summary of the FEIS.
The NAU Project, LLC	242913	17	Impacts on American Indian Resources This section should recognize that even though there would be impacts on American Indian Resources of	The discussion of the impacts to American Indian resources is based upon American Indian perception

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			varying degree, that these impacts under the Law would not in themselves likely prevail in a site specific EIS from preventing operations in that area. On public lands, the burden placed on Native Americans is very high. Two examples in Arizona exemplify this proposition, one is Havasupai v. US Government and the 9th Circuit Court of Appeal's Snow Bowl decision. Substituting the specificity of a cite specific project EIS, with an overarching area EIS (as this one is) with the uncertainties and global assumptions that go with it, is bad policy. To make a withdrawal under these conditions and providing relief to Native peoples thereby, is in fact giving defacto title to these areas to Native peoples, when in fact their aboriginal tile was extinguished in the late1800s as was explained in the Havasupai v. U.S. Government decision. From Page ES-13: There are no tribal trust resources or assets within the proposed withdrawal area; however, all alternatives could result in long-term indirect impacts of unknown magnitude on Havasupai Springs, which is located outside the proposed withdrawal area. It is unclear what long-term "Unknown Magnitude" indirect impacts are being referred to here. The Impact definitions do not include "Unknown Magnitude" as one of the options. The impact to Havasu springs was found to be none to negligible and that is taking into account that the assumptions stated were absurd to begin with. Unless a better statement is made that supports what the unknown magnitude is, this statement should be deleted. This is another example of BIAS. Alternative A would have a major long-term direct impact on resources on all three parcels including disturbance to a Traditional Cultural Place, From Chapter 4, I am assuming that the TCP referred to in the South Parcel is Red Butte. Additional exploration directly in the vicinity of Red Butte is a legitimate concern. However, withdrawing major portions of the South parcel is not the solution. Individual EAs or even EISs are the proper level of investigation for this area.	of adverse impacts due to mining activity. The EIS acknowledges that this is a qualitative measure of impact and that it cannot easily be quantified in Section 4.12.1, Impact Assessment Methodology and Assumptions. The assessment of potential impacts of "unknown magnitude" to Havasupai Springs is based on input from the Havasupai Tribe on their concerns about mining effects to the springs. Perceived impacts to the springs may influence how the Havasupai view the spring and therefore, would impact the cultural function of the spring. Regarding potential impacts to the Red Butte TCP, individual NEPA analysis would be conducted for any new project in and around Red Butte. Red Butte and areas to its north have been determined eligible for inclusion in the NRHP as a TCP, in accordance with NHPA guidelines for assessing and designating TCPS. Identification of an historic property as a TCP eligible for inclusion on the National Register does not remove the land from other types of uses or activities. The purpose of this EIS is to inform the Secretary of the Interior about the potential impacts to all resources by the Proposed Northern Arizona Withdrawal and alternatives.
The NAU Project, LLC	242913	40	Indian Cultural Resource Internet research on the Kayenta Mine and the Navajo Generating Station was very interesting in regards to Native Indian cultural resources. There is a great debate amongst those in the area with regards to cultural resources and how the mine and generating station affect these resources. However, the Navajo Nation receives about 30 million dollars or more in royalties and over 60 million in payroll annually from the operation of these two enterprises and have vigorously defended any attempt to shut down the mine or power plant, despite the disturbance and insult that is created in regards to their cultural resources. The willingness of the Navajo and Hopi to accommodate the mine and generating station's affects on their cultural resources when they benefit economically from them should be included in the DEIS as part of the existing cumulative effects on Indian Cultural Resources. There is copious documentation on the internet of the cultural resources affected by the mine and generating station. To say that Native American religious beliefs of the Hopi and Navajo find exploration and mining abhorent, while at the	Analysis of tribal land use within reservation boundaries is out of scope of the analysis of the EIS. The EIS analysis is confined to effects of the Proposed Action and alternatives on resources and values of concern to American Indians. The strong objection specifically to uranium mining is discussed in Section 3.16, Social Conditions, of the EIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			same time profiting by the same kinds of commercial enterprises on their own lands is hypocritical. It introduces a large bias into the DEIS that must be balanced by discussing what these Native Nations actually do. In other words, actions speak louder than words. A place to start is: http://coaldiver.org/Kayenta/	
The NAU Project, LLC	242913	68	Section 4.12 American Indian Resources My general comments on this section is that by its very nature, the impacts considered here are subjective. Withdrawing such large areas of land based on subjective impacts to American Indian resources where the location of the individual mines is unknown, is in fact giving defacto title to these lands to native peoples. The environmental impact statements required for individual projects is the proper venue to address these issues as the specific mine site and specific American Indian resources in question are both known. In "Havasupai Tribe v. United States" concerning the specific mine site of the Canyon mine, the Havasupai were unable to prevail and prevent the approval of mine operations. To thus withdraw from mineral entry (vast areas) which could not be done, for most specific cases with much smaller amounts of land considered, based on the Laws of the United States is unfounded and would set dangerous legal precedent. While it is necessary and correct to determine the impacts on American Indian resources in this Overarching EIS for the Grand Canyon area it would be overreaching to base a withdrawal decision for over a million acres based solely or in part on them. Any areas of great impact identified by this EIS should be identified and address by the individual EIS that would be conducted for a specific mining location in the area affected, and any specific issues litigated in court if such be necessary.	The discussion of the impacts to American Indian resources is based upon American Indian perception of adverse impacts to their culture due to mining activity. The EIS acknowledges that this is a qualitative measure of impact and that it cannot easily be quantified in Section 4.12.1, Impact Assessment Methodology and Assumptions. The effects to American Indian resources are just a portion of the overall factors that will be considered by the Secretary of Interior when making the decision for a proposed withdrawal. Sections 3.11, 3.12, 4.11 and 4.12 have been revised to use consistent terms that more closely track and explain legal requirements under applicable legal authorities.
The NAU Project, LLC	242913	69	Page 4-210 It is important to note that many American Indians view exploratory drilling and mining as wounding the earth. Past mining activities that are visible on the surface are seen as wounds that cannot scab over or heal (Nuvamsa 2008). Any drilling into the earth, regardless of size, is considered a wound to the earth. In commenting on other projects in the withdrawal area, the Hopi have repeatedly stated that the earth is sacred and should not be dug up for commercial reasons (Forest Service 1986a). Other tribes believe that repeated wounding of the earth can kill their deities and by extension a sacred site. While I acknowledge the above statement, I believe that the counter argument should have been considered and included in this DEIS. The counter argument is this. Both the Hopi and Navajo nations receive and aggressively defend their royalty incomes and employment due to mining coal and the operation of the Navajo Generating Station on their reservations. The Hopi went so far as to expel conservation group activists from their Reservation because these groups threatened the majority of income the Hopi rely on. This income is derived from Coal Mining. A excerpt from an article by Anne Minard for the Four Corners Free Press dated March 2010 provides insight	Analysis of tribal land use within reservation boundaries is out of scope of the analysis of the EIS. The EIS analysis is confined to effects of the Proposed Action and alternatives on resources and values of concern to American Indians.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			into the view points presented in the DEIS and the counterpoint I presented.	
The NAU Project, LLC	242913	70	Page 4-212 One place of concern is Havasupai Springs, which may suffer from contamination from the mining activity as well as from effects of other activities (see Section 4.4, Water Resources). Using the phrase may suffer is misleading, Havasu Springs is not endangered of being contaminated, even using the absurd assumptions in Section 4.4. This sentence should be deleted. The justification is from page 4-77: 2. The average ambient concentration of dissolved uranium is about 6 µg/L in the discharge from Havasu Springs, about 7 µg/L for Blue Springs, about 4 µg/L for a small R-aquifer spring along the South Rim, and about 3 µg/L for either Hermit or Garden springs (see Table 4.4-5). 3. The average ambient concentration of dissolved arsenic is about 10 µg/L in the discharge from Havasu Springs, about 5 µg/L for Blue Springs, about 10 µg/L for a small R-aquifer spring along the South Rim, about 10 µg/L for Hermit Springs, and about 4 µg/L for Garden Springs (see Table 4.4-5). The resulting projected total concentration of dissolved uranium is 6 µg/L for Havasu Springs and 7 µg/L for the nearest part of Blue Springs (see Table 4.4-5). The projected concentration of dissolved arsenic is 10 µg/L for Havasu Springs and 5 µg/L for the nearest part of Blue Springs. None of these concentrations exceed the ambient levels. The ambient arsenic concentration for Havasu Springs is equal to the EPA MCL for drinking water (10 µg/L) for humans. These results would represent a range from no impact to negligible impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Overall, the section on American Indian Resources is BIASED. A balanced presentation of what the actual practices of local Native Americans are with regards to mining near the affected areas is not presented.	The assessment of potential impacts to Havasupai Springs is based on input from the Havasupai Tribe on their concerns about mining effects to the springs. Perceived impacts to the springs may influence how the Havasupai view the spring and therefore, would impact the cultural function of the spring. This perceived contamination could be detrimental to Havasupai culture regardless of the actual levels of uranium. In order to comply with Section 106 of the NHPA and as set forth in the BLM Manual Handbook H-8120-1, *Guidelines for Conducting Tribal Consultation*, BLM is required to consider the Havasupai concerns about the effects to the spring. Discussion of possible effects to the spring are discussed under Cumulative Impacts in Section 4.12.2, American Indian Use Areas, of the FEIS.
Hualapai Tribe-Office of the Chairman	225270	5	Chapter 3.2.2., Page 3-20. The DEIS should reference the State of Arizona's obligation to engage in meaningful government-to-government consultation with Indian Tribes pursuant to Arizona State Executive Order 2006-14. This Executive Order applies to state decisions impacting Arizona Indian tribes such as air quality and permitting decisions. Section 106 of the National Historic Preservation Act (NHPA), 16 U.S.C. § 470f, requires that, prior to approving the expenditure of any federal funds on undertaking with the potential to affect historic properties, or prior to issuing any license or other authorization for such an undertaking, the federal agency must engage in the consultation process mandated by NHPA section 106, a process that has been implemented through regulations issued by the Advisory Council on Historic Preservation. 36 C.F.R. § 800. We note that the ACHP regulations authorize agreements between federal agencies and Indian tribes to specify how an agency's responsibilities under the ACHP regulations relating to tribal participation will be carried out. 36 C.F.R. § 800.2(c)(2)(ii)(E). It may prove to be	The Section 106 undertaking under consideration is the proposed withdrawal of approximately 1 million acres. Through consultation with the State Historic Preservation Officer, it has been determined that the withdrawal itself would not adversely affect historic properties. Under 36 CFR 800.14(b), a Programmatic Agreement (PA) may be developed to address the resolution of adverse effects. Since the proposed withdrawal would not have adverse effects, a PA is not needed. Such a programmatic agreement, while possibly conforming to the NHPA, is beyond the scope of this EIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			mutually advantageous for the Department of the Interior/Bureau of Land Management and our Tribe to consider entering into a Programmatic Agreement (PA) specifically for the Northern Arizona Proposed Withdrawal Project. We note that a federal or federally assisted undertaking that has the potential to affect historic properties that hold religious and cultural significance for our Tribe may also have effects on places and things that are subject to mitigation measures not specifically noted within the DEIS. Therefore, entering into a Programmatic Agreement specifically for the withdrawal project would present a venue for accountability and mutual collaboration. It is important to point out that mitigation measures are an element of PA's yet, entering into a PA arrangement was not mentioned in the DEIS. Requirements that include review of operations, monitoring, remediation, research and interagency oversight are integral to programmatic agreements giving all stakeholders an element of cooperative bilateral management. As an important note in this matter, Hualapai in particular, did not agree with, nor sign the 1997 Nationwide Programmatic Agreement which is inconsistent with NHPA Amendments requiring consultation with Indian tribes. The 1997 NPA is also inconsistent with ACHP regulations 36 C.F.R. part 800 as revised in 1999 and 2000 to implement the 1992 NHPA Amendments. Rather than perpetuate inconsistencies within the Nationwide PA, we prefer the withdrawal project initiate a PA that is specific to the Northern Arizona project.	
Hualapai Tribe-Office of the Chairman	225270	6	Executive Summary, Page ES-13, Impacts on American Indian Resources. We oppose the statement *There are no tribal trust resources or assets within the proposed withdrawal area*. Indeed, to the extent that the DEIS describes areas of Tribal cultural, archeological or sacred sites within the withdrawal area, they qualify as tribal trust resources.	According to BLM Manual Handbook H-8120-1, Guidelines for Conducting Tribal Consultation, cultural resources on BLM land are not trust assets or resources (BLM 2004:IV-1). According to the handbook, Indian trust assets or resources are "lands, natural resources, money, or other assets held by the Federal Government in trust or restricted against alienation for Indian tribes and individual Indians (Secretarial Order No. 3215, April 28, 2000)." Trust assets must be tied to property and are defined by legal agreements between the Federal Government and tribal governments. Although archaeological and places of traditional importance in the proposed withdrawal areas do not fit the legal definition of trust assets, their continued importance to tribal heritage values is considered by the BLM.
Hualapai Tribe-Office of the Chairman	225270	7	Chapter 1, Page 1-8. The section referencing the Hualapai states that the tribe holds a substantial portion of the project area to be culturally significant. This section omits important reference to the Hualapai Tribe's historic existence throughout parts of the moratorium area. It is the aboriginal existence of Hualapai in the moratorium area that establishes its cultural and natural resource dependence on the region. These resources	Section 1.4.2, Cooperating Agencies, has been revised in the FEIS to reflect the existence and history of the Hualapai Tribe in this area. Information about and analysis of the Hualapai Tribe's interests in the proposed withdrawal area and alternatives in determining if the proposed withdrawal, or one of the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			qualify for federal protection because they evidence Hualapai's existence in the region which is intimately intertwined with its cultural survival.	alternatives, is indicated to be necessary to protect the lands can be found in the FEIS in Sections 3.12 and 4.12, American Indian Resources.
Hualapai Tribe-Office of the Chairman	225270	8	Chapter 1.5.3 Introduction, Page 1-24. The federal and state governments are charged with protecting archeological and Indian cultural resources on federal lands and with investigating and prosecuting looting and/or vandalism of these resources pursuant to the Archeological Resources Protection Act, the NAGPRA and local heritage protection laws. The BLM must acknowledge its responsibility by analyzing the potential illegal looting or vandalism of these resources in the moratorium area. On the Arizona Strip, whenever land is open to increased outsider activity, such as road development, mining and exploration of resources, the looting and damage to cultural and natural resources increases. Private businesses are often unaware of or ignore federal or state historic preservation laws when on federal lands or near Indian lands. Thousands of cultural items have been removed and/or destroyed during previous exploration activity. In terms of Cultural Resources, this problem is specifically alluded to in Chapter 3 (pp 3-205 - 3-206). The EIS should acknowledge this issue, even if the effects are difficult to predict.	As stated in Section 1.5.3, Issues Eliminated from Detailed Analysis of the EIS, potential vandalism was not considered in the analysis of the alternatives. Because potential vandalism is an illegal activity it is considered a law enforcement issue.
Hualapai Tribe-Office of the Chairman	225270	9	Chapter 3.11, Page 3-8. Road construction and use for mining exploration and development usually results in exposing previously isolated areas to casual and recreational vehicle traffic. Consequently, archeological, cultural and sacred sites previously protected by isolation will be exposed and endangered. This indirect, but meaningful impact has already occurred on the Arizona Strip.	As stated in Section 1.5.3, Issues Eliminated from Detailed Analysis of the EIS, potential vandalism was not considered in the analysis of the alternatives. Because potential vandalism is an illegal activity it is considered a law enforcement issue.
Hualapai Tribe-Office of the Chairman	225270	10	Chapter 3.11, Page 3-202. The site density figures would be more easily grasped and compelling if they were presented in per/square miles. Figures such as .03 or .05 per acre are difficult to conceptualize spatially.	Section 3.11.2, Identification of Prehistoric and Historic Cultural Resources, has been revised consistent with your suggestion.
Hualapai Tribe-Office of the Chairman	225270	11	Chapter 3.11.1, Page 3-201. This section should refer to cattle grazing, homesteading, timbering, etc., not in the past tense but rather as lifestyles that continue today among the affected Indian tribes.	Section 3.11, Cultural Resources, has been revised consistent with your suggestion.
Hualapai Tribe-Office of the Chairman	225270	12	Chapter 3.12.1 & 2, Pages 3-207 & 3-212. The Kaibab National Forest and the Arizona Historic Preservation Office have determined that Red Butte is National Register Eligible. Their decision is based, in part, on information provided by the Hualapai Tribe that Red Butte qualifies for Traditional Cultural Property and for some of the reasons noted in these paragraphs.	The information on the NRHP-eligibility of Red Butte has been added to Section 3.12.2, American Indian Use Areas.
Hualapai Tribe-Office of the Chairman	225270	13	Chapter 3.12.2, Page 3-213. The trails referenced are part of an extensive network connecting the Rio Grande Pueblos with Zuni, Hopi, Havasupai, Hualapai, Mojave and other tribes to the Pacific Ocean. It is erroneous to simply state that they run from Hopi "to" Havasupai, since they extend well	The section on Trails in Section 3.12.2 will be expanded to include information concerning a large network of trails.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			beyond Hopi and Havasupai. In fact, there are sections of the trail network that were documented on early GLO maps dating back to 1900. It is generally correct that the trails cross through the northern part of the South Parcel; however, there are trail and "road" segments on the early GLO maps that are east of Red Butte in the southern area of the South Parcel, as well. More work is needed to understand the extent of these trails.	
Hualapai Tribe-Office of the Chairman	225270	14	Chapter 4.12 American Indian Resources, 4-208ff. Native American affiliated archaeological sites should be considered a Native American Resource as well, as they are evidence of tribal homelands, represent cultural heritage, are considered integral to maintaining cultural identity, are important for teaching history through the generations, and are important for teaching respect for the ancestors.	The NHPA defines those sites that are eligible for protection and the FEIS will not serve to define sites eligible for protection in any way contrary to existing law. Section 3.12 explains what the FEIS considered to be a Native American resource. Impacts to archaeological sites are considered under Section 4.11, Cultural Resources.
Hualapai Tribe-Office of the Chairman	225270	15	Appendix H, Page H-5. The term "Anasazi" is obsolete. We suggest, in this instance, referring to the "Virgin Branch of Ancestral Puebloan or Ancient Puebloan." In addition, we question the accuracy of the statement that they were "northwest and west of the proposed withdrawal area." Although this archaeological culture" was indeed centered north of the Grand Canyon, they were likely in the area encompassed within the North Parcel. We suggest that the DEIS include more detailed research into this topic.	The term “Anasazi” is still commonly used in non-academic discourse and recognized by the public. In line with academic and tribal preferences, references to the Anasazi in Appendix A, Section I.4.1 have been changed to Virgin Branch or Ancestral Puebloan, Virgin Branch. Additional information on the Ancestral Puebloan, Virgin Branch within the proposed withdrawal can be found in the cultural resources report: *Class I Cultural Resources Overview for the Northern Arizona Proposed Withdrawal on the Bureau of Land Management Arizona Strip District and the Kaibab National Forest, Arizona* (Seymour et al. 2010).
Hualapai Tribe-Office of the Chairman	225270	16	Appendix H, Generally. It is probably an overstatement that Euler "demonstrated" that Cerbat culture, initially (from about A.D. 7001150) restricted to the Lower Colorado River, expanded eastward and onto the Colorado Plateau after about A.D. 1150, and were not related to the Cohonina archaeological culture. This is one point of view, and is at odds with Pai traditional culture history. It would be more accurate to state that Euler "inferred" this reconstruction.	Euler’s conclusion was a hypothesis which contradicts the viewpoints of some archaeologists as well as Pai traditional history. Appendix I, Section I.4, Formative of the FEIS has been revised consistent with the comment.
Hualapai Tribe-Office of the Chairman	225270	17	Appendix H, Page H-14. It would be better scholarship to attribute the statement "Pai (Hualapai and Havasupai) and Paiute use of the Grand Canyon region, which began after ca. A.D. 1300" to Robert Euler or other earlier archaeologists rather than to Bungart, as the 1994 reference was based purely on surface survey information and previous research.	Appendix I, Section I.5.1, Hualapai, Havasupai, and Yavapai, of the FEIS has been revised consistent with the comment.
Hualapai Tribe-Office of the Chairman	225270	18	Appendix H, Page H-14. We recommend revising the following sentence: "The Hualapai speak a Yuman language called Hualapai, which is related to Havasupai (McGuire 1983)", to read: "The Hualapai, Havasupai, and Yavapai languages are a group of related Upland Yuman languages	Appendix I, Section I.5.1, Hualapai, Havasupai, and Yavapai, of the FEIS has been revised consistent with the comment.

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Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			(Kendall 1983).(Kendall is in the same edited volume as McGuire 1983).	
Hualapai Tribe-Office of the Chairman	225270	19	Appendix H, Page H-15. Please note that Kniffen's description of the Hualapai bands was superseded by Dobyns and Euler (1976:16-18), who identified 13-14 bands, which were grouped under broader geographic divisions.	Appendix I, Section I.5.1, Hualapai, Havasupai, and Yavapai, of the FEIS has been revised consistent with the comment.
Hualapai Tribe-Office of the Chairman	225270	20	Appendix H, Page H-15. We request changing: "The Hualapai were driven from much of their homeland in the Hualapai War of 1866–1869", to: "The Hualapai were driven from much of their homeland as a result of conflict with the U.S. Army during 1866–1869." The former sentence implies that the Hualapai were unilateral aggressors rather than a people defending their aboriginal homelands. The Hualapai were essentially gathered from the moratorium region and confined to their present day reservation.	The term “Hualapai War of 1866-1869” can be used to encompass the conflicts between the Hualapai and the U.S. Government and is not meant to suggest the Hualapai were the aggressors in the conflicts; however, Appendix I, Section I.5.1, Hualapai, Havasupai, and Yavapai, of the FEIS has been revised consistent with the comment.
Hualapai Tribe-Office of the Chairman	225270	21	Appendix H, Page H-15. Closer to the moratorium areas, the Havasupai also conducted Ghost Dances, including in areas on the plateau in the vicinity of the South Parcel. The Ghost Dance was introduced by Paiutes from north of the Colorado River.	Thank you for the information regarding the Havasupai practice of the Ghost Dance. Appendix I, Section I.5.1, Hualapai, Havasupai, and Yavapai, of the FEIS has been revised consistent with the comment.
Hualapai Tribe-Office of the Chairman	225270	22	Appendix H, Page H-16. The sentence "Havasupai and Yavapai had been close friends" should be amended to include Hualapai. Subsequent to the split, the Hualapai and Havasupai remained close, and both Hualapai and Havasupai became adversaries of the Yavapai.	Appendix I, Section I.5.1, Hualapai, Havasupai, and Yavapai, of the FEIS has been revised consistent with the comment.
Hualapai Tribe-Office of the Chairman	225270	23	Appendix H, Page H-19-21. The sections on the Navajo, Hopi, and Zuni Indian tribes are too brief and general. As trustee, the BLM and NPS must be thorough in its treatment of the tribes’ historical and cultural connection to the withdrawal area and the potential impact to the future of their historic sites and cultural resources.	Appendix I Sections I.5.3, Navajo, I.5.4, Hopi, and I.5.5, Zuni, in the FEIS has been revised consistent with the comment
Hualapai Tribe-Office of the Chairman	225270	24	Chapter 3.4, Page 3-6. The Hualapai Tribe considers all springs in the moratorium area as sacred sites.	Thank you for the information on Hualapai beliefs about springs in the proposed withdrawal area. Section 3.12.2, American Indian Use Areas of the FEIS has been revised consistent with the comment.
Hualapai Tribe-Office of the Chairman	225270	25	Chapter 4.11.2. 4-203. We do not agree with the statement: *It is assumed that the majority of archaeological sites determined eligible for the NRHP would be valued for their potential to yield important information* (or would be evaluated as eligible only under Criterion D). This may be a true statement from a scientific or archaeological perspective. Importantly, Indian tribes value ancient sites using different criteria, such as Criterion A, but also under Criteria B and C. Even applying Criterion D, a site may be considered important for its information value by tribal members, but not necessarily scientific research potential.	It is expected that the proposed withdrawal area includes a range of historic properties that may be eligible under one or more of the National Register criteria. Each site’s eligibility would be evaluated in reference to all four criteria in order to determine which are applicable. Language clarifying the process for determining if a historic property is eligible for inclusion in the NRHP has been added to Section 4.11.2, Compliance with Environmental Regulations and Permitting of the FEIS.
Hualapai Tribe-Office of the	225270	27	Chapter 3, Page 3-151. Bald Eagle. The Bald Eagle is highly significant to the culture and religious customs and beliefs of the Hualapai and other	Thank you for the information regarding the role of the Bald Eagle in Hualapai culture. Section 3.12.2,

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Chairman			affected Indian tribes. The DEIS should reference the significance of this bird species to the affected Indian tribes.	American Indian Use Areas of the FEIS has been revised to include the information provided.
Hualapai Tribe-Office of the Chairman	225270	29	Vegetation Species of Concern Kaibab Agave. Kaibab agave (Agave utahensis var. kaibabensis) is found in proximity to the three proposed sites, is a Grand Canyon National Park Service "species of concern" and is a species of cultural significance to Hualapai. Damage to Kaibab agave species is a threat to Hualapai cultural integrity and perseverance. The persistence of healthy agave communities ensures a continuation of harvesting practices and uses evidenced as in recorded pre-colonial and contemporary practices.	Thank you for the information regarding the role of the Kaibab agave in Hualapai culture. Section 3.12.2, American Indian Use Areas of the FEIS has been revised to include the information provided. Note that in the vegetation section of Chapter 3 of the EIS, Kaibab Agave is identified as not occurring within the proposed withdrawal area.
Navajo Nation Historic Preservation Dept	165632	2	The Bureau of Reclamation needs to understand the Navajo Nation claims cultural affiliation to prehistoric people beginning with Paleoindian to Pueblo IV of the Anaasazi prehistoric cultures. Navajo ceremonies refer to places such as Mesa Verde, Chaco Canyon, Salmon Ruins, Canyon de Chelly, and Aztec Ruins. And all four river tributaries are mentioned in songs, prayers and even sandpaintings. There is no such terms as "Ancestral Puebloan" in Navajo culture and religion.	Thank you for the information regarding Navajo culture history. Section 3.12.1, Traditional Cultural Values and Practices has been revised to include the information provided.
Economic Conditions				
Dave A.	52012	2	BLM is grossly inflating revenue projections for uranium mining and fails to reveal that most revenues go to Utah or overseas, not Arizona.	Revenues are conventionally defined as gross receipts on sales which cover salaries and wages paid, supplies, electricity, and other operating costs which are largely expended within the study area. It does not matter where the sales are realized – the costs they cover are incurred in the Study Area and are counted toward GRP. The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Robert Grossman	54251	3	There is no mention of a Cost-benefit analysis per 1502.23	NEPA does not require, and typically does not include, cost-benefit analysis. As noted in CEQ regulation 1502.23, "For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations."
Sustainable Economic Development Initiative	54353	3	There are several important negative impacts of these accidents not considered in the DEIS, including the economic impact on the Grand Canyon tourism. The procedures for dealing with accidents involving even low concentration uranium ore are complex and time consuming, and could involve multi-day road closures or significant traffic delays. (See Hammon Trucking, "Traffic Accident or Cargo Spill Response Procedure	Further discussion of the potential frequency of haul-related accidents and spills is provided in the FEIS at Section 4.16. The comment that uranium ore hauling would significantly impact visitation to the Grand Canyon and corresponding tourism-related economic activity is unsubstantiated.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			for shipments from Denison Mines [USA] Corp.'s Arizona Strip Mines to the White Mesa Mill", January, 2010; and Denison Mines [USA] Corp., "Transportation Policy", July 5, 2007.)According to the accident procedures of Denison's trucking subcontractor, such accidents could involve cargo spills, injuries, fires, fuel spills, downed power lines, traffic hazards, and potential pollution of streams or rivers. Uranium ore hauls from the east and south parcels totaling 91,780 trips, utilize the only road access routes to the Grand Canyon access routes would significantly impact the approximately 5 million annual visitors and $687 million in annual regional economic activity created by the Grand Canyon. (Northern Arizona University, "Grand Canyon National Park Northern Arizona Tourism Study", April 2005.)	
Sustainable Economic Development Initiative	54353	4	There are several important negative impacts of these accidents not considered in the DEIS, including the economic and social safety impacts of accidents, injures, and deaths. Beyond the economic impact from access route closures and delays, 367 accidents, causing 151 injuries and 4 deaths would have significant direct and indirect economic and social safety impacts on the region. Although these impacts are difficult to quantify because of the unknown severity of each accidents and injury, and the unknown lost income for the wide range of potential accident victims and their families, these impacts would be significant.	See response to comment 54353: 3.
Sustainable Economic Development Initiative	54353	6	There are several important negative impacts of these accidents not considered in the DEIS, including other impacts on public safety. The 300,165 uranium ore trips planned would travel through 20 Northern Arizona and Southern Utah cities and towns with a combined population of over 120,000 people. Any accidents in or near these cities or towns would have more significant social and economic impacts than accidents on the open road.	See response to comment 54353: 3.
Tom Leszozynski	76950	2	Uranium mining can grow the economy near the park, with 1,100 mining claims within five miles of the Canyon.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Ashley Coughlin	78821	2	From an economic standpoint, this would have a great impact on the Grand Canyon National Park, as a major source of their revenue comes from river running fees, both private and commercial.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Denison Mines Corp	104145	6	Unnecessarily restricting access to uranium reserves that can help provide the nation with carbon-free electricity generation and making it impossible to maintain a stable domestic supply of a critical mineral, in circumstances where exploration, development and mining of such reserves has proven to result in no significant impacts to the environment, is in obvious contradiction to the intent of the MMPA. There is no reason to prohibit mining activities on federal lands when such activities can be performed in	Comment noted. The purpose of the EIS is to provide the information to allow BLM to evaluate the policy alternatives in the context of the Mining and Policy Act of 1970 and other acts and directives.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			a manner that results in no significant impacts to the environment.	
Denison Mines Corp	104145	8	If the breccia pipes are not developed, the energy lost must be replaced by some other resource. We must consider the environmental impacts of replacing this energy with coal, natural gas, solar arrays, or wind turbines. All of these other sources have their own material needs and carbon footprint. The U.S. currently gets 20% of its electrical energy production from nuclear energy. It is critical that the U.S. has a secure domestic supply of the uranium needed for nuclear generating stations. We already are importing over 90% of our needed uranium. According to USGS Report C.I051, the Arizona Strip holds 42% of the nation's estimated undiscovered uranium endowment. This is the equivalent of 13 billion barrels of oil and is carbon-free energy. To withdraw this critical resource from location and entry under the Mining Law, with no environmental benefit or necessity, is short-sighted and dangerous.	The nation's undiscovered uranium endowment has never been estimated by USGS. A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Sections 3.17 and 4.17 of the FEIS.
Denison Mines Corp	104145	9	The economic impact of the proposed withdrawal must also be considered. The economic impact from the job losses in northern Arizona and southern Utah would be significant. Since the revival of the uranium industry in 2004, tens of millions of dollars have been added to the Arizona economy. Significantly more funds would flow to the local economies as exploration, development and mining activities continue. The industry would also add hundreds of jobs at a time when those jobs are desperately needed.	The comparative economic impact of the alternatives was considered in Section 4.16 of the EIS. The FEIS contains a revised and enhanced economic analysis in Section 4.17.
Denison Mines Corp	104145	10	Another economic consideration is the cost to the government, i.e. U.S. taxpayers, of the proposed withdrawal. Federal law provides that prospectors and miners have a statutory right to locate mining claims for exploration, development and production of minerals. Mining claims in good standing provide these miners with vested property rights. Blocking such rights would likely subject the United States to substantial takings litigation. Furthermore, the land management agencies clearly do not have the funding and resources required to perform in a timely manner the mineral examinations required under a withdrawal scenario.	Existing claims determined to be valid through a validity examination would be allowed to move forward under any of the alternatives. See PL 94-579 Sec. 701 (Federal Land Policy Management Act).
Kanab Utah	225250	3	Nowhere in the EIS is there a discussion of uranium extraction and its impact on the national Energy Research and Development Roadmap-Report to Congress- April 2010. Section 4.3.2 R&D for Sustainable Fuel Cycle Options, p. 3 1. "The availability of fuel resources for each potential fuel cycle and reactor deployment scenario must be understood. Extended use of nuclear power may drive improvements in defining resource availability and on fuel resource exploration and mining. Primarily, this is work that the private sector would undertake, and how and when this would occur would depend on price and other market conditions. This is most relevant for a once-through approach, but even modified open cycles and full recycle systems may require comparable levels of natural sources of fuel for the foreseeable future."	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.
Kanab Utah	225250	4	Nowhere in the EIS is there a discussion of local land use planning or	Local communities were discussed in Section 3.15 and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			economic development plans.	4.15 of the EIS and that discussion has been enhanced in the FEIS based on input from affected counties and other sources. Conformance with local land use plans is discussed in Chapter 1 of the FEIS.
Kanab Utah	225250	5	Nowhere in the EIS is there a discussion of social and economic impacts on local communities as required by federal law.	Local communities were discussed in Section 3.15 and 4.15 of the EIS and that discussion has been enhanced in the FEIS based on input from affected counties and other sources. Conformance with local land use plans is discussed in Chapter 1 of the FEIS.
Kanab Utah	225250	7	The EIS list of preparers includes 52 entities, none of whom demonstrate skills in assessing social and economic impacts on local communities. In fact, the preparers are predominantly from agencies whose missions and training would lend them to a bias against resource development to provide social and economic benefit to such communities. By refusing to include preparers with an understanding of such impacts, the recommendations are biased by definition.	BLM retained additional socioeconomic expertise to assist in preparing the FEIS. In addition, economists from USGS, BLM, NPS and other federal agencies reviewed and contributed to the revised economic analysis in the FEIS.
Donald Begalke	225254	9	Other than plugging drill holes and surface maintenances, more on reclamations of habitats where mineral explorations fail must be included in assessments also. The exploring companies, failing to find minerals, must submit bonds to federal agencies for reclamations, and repairing acres and acres of lost habitats from unneeded roads and at failed-exploration sites. Soils, trees, vegetations et al must be restored on/within Public Lands, paid for by the bonds. The economics must be discussed in the final presentation of this proposed withdrawal.	The costs of reclamation activities, as described in the RFD (see Appendix B), are reflected in the analysis of the economic effects of mining.
Donald Begalke	225254	16	On Page 3-252 is "Table 3.16.1 Arizona Employment by Industry", inclusive of "State government". On reading the "State government" line for jobs during Years 1990, 2000, 2007 and 2008, I recognized the numbers reported were very highly over "true job positions for those years". Thus, I drove to the Arizona Department of Administration for correct numbers on our state-government jobs. I received a copy of the "2010 State of Arizona Workforce Report", issued September 2010, and have enclosed copies of three pages: the Director's cover letter to the Governor (Page 7 of my Comment), the "Overview" AWR Page ii (Page 8 of my Comment), and AWR Page iii 442010 Employee Headcount - ADOA Personnel System" (Page 9 of my Comment). Important to understand is that AWR Page ii shows the ADOA headcount on Line 1, and that the remaining counts are for Executive Branch offices, Judicial Branch offices, Legislative Branch offices plus offices and departments not in the ADOA Personnel System. The total job headcount for 2010 Arizona State Government jobs was 35,041 on June 30, 2010 - for the purposes of my Comment on this proposed withdrawal, this page gives us an understanding of where the numbers for the "Total" come from, and is of the same format used for prior years. Therefore, "Table 3.16.1" numbers	Different agencies count jobs (or employed persons) in different ways, including different treatment of part-time positions, self-employed individuals and other issues. The table discussed in this comment reflects data published by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). BEA data was used to describe existing employment because it provides consistency across sectors, time periods and among different counties. BEA data also provides a more comprehensive tabulation of employment (including positions not covered by unemployment insurance) than other sources such as Bureau of Labor Statistics (BLS) data.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			for Arizona State government should be changed from: Year 1990 - 61,595 jobs; Year 2000 - 81,026 jobs; Year 2007 - 87,997 jobs; Year 2008 - 88,039 jobs to Year 1990 - 34,151 jobs; Year 2000 - 42,517 jobs; Year 2007 - 41,749 jobs; Year 2008 - 40743 jobs. Using [Note: Pages 7-9 of this Comment are the photocopies of the AWR pages, this paragraph continues on Page 10] a mathematical fraction, I am positive all the corrected Arizona State-government job numbers are 99% accurate.	
Donald Begalke	225254	17	On Page 3-250 of the Economic Conditions section, providing "the latest information" is a stated goal (see 2nd to last line in the paragraph "Industry Employment". Years 2007 and 2008 are used in the tables, and are not the "latest information". I had been informed this Draft went to printing during Fall 2010. Yet Year 2009 data was not used nor was the available latest data for Year 2010 used appropriately where could have been. We must remember that two recessions in the U.S. have occurred during the last seven years, and in my opinion Arizona is still in the latter, deeper recession. Were not the numbers et al of this Economic Conditions section, reviewed and assessed, before this Draft was sent for printing? For Arizona the section contains too many suspect numbers.	Economic data cited in Chapter 3 has been updated for the FEIS, where available and feasible. For many data sources, 2010 information was not available at time of analysis for the EIS.
Donald Begalke	225254	18	(on Page 3-253) "Table 3.16.2 Utah Employment Industry". Utah's "State-government line" under the 2008 column has the total of 88,039 jobs. That same number of Utah jobs appears in the corresponding box for 2008 Arizona State-government jobs on Page 3-252. The same high-distortion problem affects Utah State government jobs' numbers for 1990, 2000, 2007and 2008 too. Why did BLM not directly contact the Utah State human resource office for the jobs numbers for this Draft.	Different agencies count jobs (or employed persons) in different ways, including different treatment of part-time positions, self-employed individuals and other issues. The table discussed in this comment reflects data published by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). BEA data was used to describe existing employment because it provides consistency across sectors, time periods and among different counties. BEA data also provides a more comprehensive tabulation of employment (including positions not covered by unemployment insurance) than other sources such as Bureau of Labor Statistics (BLS) data.
Donald Begalke	225254	19	(Page 3-255) "Table 3.16.4 Mining Sectors: Industry Employment, Using IMPLAN (2008)", a typo has occurred on the 4th Line under " Total". Should this Table 3.16.4 also identify Uranium Mining and Support Activities for Uranium Mining with appropriate numbers across respective lines? Would not road maintenances and transmission-lines' inspections and repairs be some of the activities supporting uranium mining? Please, correct for the Final EIS, and complete also where appropriate for the Final EIS	The table referenced in this comment has been corrected and updated for the FEIS. See Section 3.17.
American Clean Energy Resources Trust (ACERT)	225256	18	Page 1-9 Kane County, Utah Statement: *Because of its proximity to the proposed withdrawal area and its historic dependence on the Arizona Strip as a significant source of income and employment for its residents, Kane County is participating as a cooperating agency in the EIS process. Kane*	The reference cited for this statement in the DEIS was incorrect. The correct reference is BLM 2005b.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			County had an estimated population of 6,577 in 2008 (U.S. Census Bureau [Census Bureau] 2008a). Like Coconino County, Kane County's economy is primarily tourism based. lake Powell, Zion National Park, and other recreation sites attract tens of thousands of visitors each year. As a result, the leisure/hospitality services sector is the leading employment sector. The mining industry is also a Significant employer in Kane County. Mining wages and salaries per job have consistently been the largest in the study area and have experienced steady growth from 1980 through 2000. However, it should be noted that the number of mining jobs in Kane County has been low since at least 1980 (BIM 2008c). Comment: Upon review of your reference (BLM 2008c), we could find no evidence of your above statement regarding mining jobs in Kane County. Please provide the exact reference for our review.	
American Clean Energy Resources Trust (ACERT)	225256	56	Page 3-254 through 257 Statement: Entire Section Comment: The poverty level for a family of four is $22,350 per year. The average wage in Kane County is $26,836 per year. The withdrawal of any of the Northern parcel condemns single earner families in this part of rural Utah and northern Mohave County to an existence at about 1.2% of poverty for the foreseeable future. Is this the anti-rural-poverty platform of the Obama Administration?	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	57	Page 3-255 Statement: copied from page 3-262 of the DEIS: *The largest employers for Kane County are Best Friends Animal Sanctuary, Aramark (Lake Powell Resorts), Kane County School District, Kane County Hospital, the federal government, Kane County, Honey IGA Supercenter, State of Utah, Thunderbird Restaurant/Motel, Parry Lodge, Zions First National Bank, Glazier's Food Town, Zion Mountain Resort, Quality Inn, Abundant Life Academy, Best Western Red Hills, and Ponderosa Resort (Utah Department of Workforce Services 2009).*Comment: The table indicates that Kane County has very limited tourism related employment using the Tourism Impact Ratios. It is inaccurate to use the Tourist Impact Ratios on Kane County as the majority of the largest employers in Kane County are hotels and motels, restaurants and related businesses which are clearly tourist related.	Discussions of the contribution of tourism to the economies in the study area in Section 3.17 of the FEIS have been revised and no longer rely on national tourism impact ratios.
American Clean Energy Resources Trust (ACERT)	225256	58	Page 3-255 Comment: Please correct the typos on the fourth line, Mining cooper - should be copper and the total should be 294.2 not 29402. These kinds of errors demonstrate the complete lack of credibility in this report.	The referenced table has been updated and corrected in Section 3.17 of the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	59	Page 3-256, 3-257 Statement: *Although the tourism-related sectors (i.e., sales and related occupations, food preparation and serving related occupations) provide more industry employment than the mining sector in the study area, wages for employees in these sectors are typically low ..• actual tourist-related employment totaled 10,296 in 2008 ... using the TI ratios, approximately 4.8% of total employment in the study area is*	The discussion of the existing contribution of tourism and mining to the study area economy has been revised in Section 3.17.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			attributable to tourism ... According to the Bureau of Labor, the 2009 mean annual wage for an Arizona employee in the food services sector was $21,230 ... Within the mining sector, which qualifies under the 'construction and extraction' industry, mean annual wages for various mining jobs ranged from $44,510 to $72,060. Comment: This section is very poorly written as is much of the entire DEIS. This section is both confusing and misleading in that it compares apples to oranges and then uses bananas as the example of a fruit salad that includes coconut but, sometimes, apples and/or oranges as well as an occasional grape and/or kumquat. With a tourism-related sector mean annual wage of little more than $21,000 versus the mining sector with mean annual wages ranging from $44,660 to $72,000 (more than two to three times the tourism-related sector), it should be clear to any but the daft where the living wage jobs exist within the entire area. This statement speaks volumes. If you're talking about the tourism-related sector, use numbers for that entire sector, not merely a part of it like food services. Also, it is disingenuous to avoid including the federal poverty numbers for comparison. For example, families and children are defined as poor if family income is below the federal poverty threshold. The federal poverty threshold for a family of four with two children was a yearly family income of $22,050 in 2010, $22,050 in 2009, and $21,200 in 2008.	
American Clean Energy Resources Trust (ACERT)	225256	60	Table 3.16-20, Page 3-275 Comment: The amount of U30 a in the Arizona Strip area as estimated by the US Geological Survey is 163,380 tons, (326.76 million pounds) (see Table 3.3-1, page 3-35 and Appendix B, Table B-4, page B-25). Yet when making statements as regards the total amount of U30 a in the country the DEIS uses the 2003 values from the EIA of 123 million pounds in Arizona, Colorado, and Utah combined (see Table 3.16-20, page 3-275). This leads to the conclusion that the amount of resource in Arizona is not significant with regard to the entire country. This discrepancy needs correction and resolution, because it is often quoted in the media (and in economic analyses) without the background mentioned above. The reader of this document would think that the resources in Arizona are not Significant.	The USGS estimates are of mineral endowment, not reserves. The EIA estimates are of reserves as defined by the EIA (economically extractable at a given price). The USGS estimate includes undiscovered resources and known resources that have not been explored. The EIA estimate includes only known deposits that are well enough explored to determine how much uranium can be economically extracted given a set of economic assumptions as to costs and revenues. The two estimates are not comparable. A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	109 & 110	Pages 4-245 to 4-269 Pages 2-44 and 2-45, Table 2.8-1 Statement: Entire Section Comment: Under Alternative A the following impacts may be expected according to the DEIS: Economic Activity The DEIS estimates that a maximum of 57 persons and their families would migrate into the area. However, there will also be an increase in business from material suppliers, construction, administrative personnel, and professional service providers. Each mine would provide jobs for 75 individuals. The total direct employment over the 20-year period would be 2,250 employees, and the indirect and induced employment is expected to create an additional 4,398	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			jobs. The overall increase in employment in the area will be 0.05%. The "overall regional tourist activity and associated employment are unlikely to be affected." The average wages for tourism (predominantly food services) is $21,230 and for various mining jobs ranging from $44,510 to $72,060 (pages 3-256 and 3-257). Thus the mining sector wages are 2 to 3.5 times higher. The direct impacts of all the uranium mines over the 20-year period for value added and output provides a total of $5.46 billion, that is, an annual average impact of $273 million. The "total value added and output for all phases of mining activity over 20 years would be $68.9 million" "or an annual average impact of $3.41 million." The DEIS notes that "mining activities associated with Alternative A are not anticipated to alter regional output, as the over all influx of visitation to tourist areas within the study area is unlikely to change." The total mining sector output will increase by an estimated 102% per year. Employment. Personal Income, and Unemployment Under Alternative A direct "labor income would increase an estimated $613.7 million over 20 years, or an annual average of $30.69 million." Indirect and induced employment would produce "the addition of 4,398 jobs (which) would result in an estimated $349.16 million in added labor income, or an annual average of $11 .64 million." "Regardless of the alternative, no impacts to the mill are anticipated." "Communities in both southern Utah and northern Arizona that are included in the study area have economies tied to the lands proposed for withdrawal." They have high unemployment, so "the additional employment opportunities could serve to benefit the overall study area by decreasing unemployment."	
American Clean Energy Resources Trust (ACERT)	225256	109 & 110	CONTINUED... Taxes and Revenues State taxes for all 30 mines would be $68.1 million, an annual average of $3.4 million. Federal tax revenues are estimated at $239.25 million for all 30 mines, an annual average of $11 .96 million. Indirect business taxes would be $229.5 million for state and local governments and $26.39 million for federal taxes. State taxes would be redistributed to local counties, which in turn would reallocate them to local communities. Recreation Economics The total estimated benefit of recreation sites in the study area is $450 million; this is not expected to change with mining. Hunting contributes $1 .53 million from the four units that cover 3.2 million acres. An average of 68 acres per year would be affected by mining-related activities; this should not impact the hunting. The DEIS analysis concludes that "no measurable reduction in air quality is expected." If the mine was located beyond 2.5 miles from the boundary of the Grand Canyon National Park, no impacts for sound and visual impacts would likely occur. Energy Resources The US used 114 million pounds of uranium for power production in 2008; this would increase to 170 million pounds in 2030. Under Alternative A the mines would produce 72.9 million pound of uranium, with an estimated value of $2.9 billion at $40 per pound. This would be available on the open market. Road Condition and Maintenance A total of 22.4 miles of new roads would be constructed under Alternative A, of which 18.8 miles would be on BLM	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			lands. This is an increase of 0.28% of the BLM road system. Another 3.6 miles of roads would be constructed on Forest Service lands, an increase of 0.49%. Mining companies would be responsible for the construction, maintenance, and reclamation of unpaved roads used for hauling ore. So the DEIS concludes that "there would be no direct or indirect impacts to road condition and maintenance." 1. The local area would benefit from getting 2,250 mining employees and 4,398 indirect jobs under Alternative A. With the high employment in the region, this would be a great boost. Should this benefit be denied to the local communities? 2. The pay scale for mining personnel is much better than those in tourism by a factor of 2 to 3.5. This would raise the overall standard of living in the area; a benefit that should not be denied as suggested by the other Alternatives.	
American Clean Energy Resources Trust (ACERT)	225256	109 & 110	CONTINUED. 3. The value added and output of the mining would bring a much needed $3.41 million annually. This should not be denied. 4. Direct labor income would increase by $30.69 million annually, while the indirect jobs would entail $11.64 million per year. These amounts would primarily be spent locally. 5. State taxes would increase by 3.4 million annually and federal taxes would get $11 .96 million every year. The dire straits that the states are in because of the recession deserve the revenues. The federal budget could also stand the benefit. 6. Tourism and other recreational activities, including hunting and fishing would not be adversely impacted. 7. Whereas the uranium mined will be sold on the open market, this will bring in foreign exchange if sold abroad. However, should a shortage of uranium supplies for the local power production arise, there could be laws restricting its use to the United States (witness what is happening in the rare earths industry). Actually the market will itself make it beneficial to sell the product in the US because it would not entail transportation costs and, therefore, would be cheaper. 8. Although not discussed in the DEIS the argument is often brought up that foreign companies would be developing and mining the uranium. It should be clarified that most of these mining companies have offices in the US, and all the labor and many of the management are US citizens. In fact, often the majority of the stockholders are also US citizens. 9. There is also a policy matter about foreign companies operating in the US. The US is a big promoter of free trade and open markets. It is considered commendable that US corporations are working in other countries. Then why is it objectionable to have foreign companies operate in the US? Should there be this double standard?	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	111	Pages 4-245 to 4-269; Section 3.16, Pages 3-250 to 3-279 Pages 2-44 and 2-45, Table 2.8-1 Comment: There are detailed discussions of Economic Conditions in Sections 3.16 and 4.16 of the DEIS. These do not need to be repeated here. There is no specific mention of the costs of transporting the ore from the mines to the mill in Blanding, UT. This will create significant revenue for the local economy, especially in northern Arizona where most of the haulers will probably be based. It is not clear	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS. Milling and hauling revenues are included in the projected price of uranium and are reflected in the economic analysis.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			that the IMPLAN model takes this into account. It is deserving of mention in the DEIS.	
American Clean Energy Resources Trust (ACERT)	225256	113	Pages 4-248, 4-249 Statement: *Total direct employment over the 20-year period under Alternative A would be 2,250 employees, or an annual average of 112. Indirect and induced employment is expected to result in an additional 4,398 jobs in the five-county study area under Alternative A. The direct and indirect increases in employment opportunities would assist in offsetting the relatively high unemployment rates in northern Arizona and southern Utah. Under Alternative A, direct employment from the mines would result in an annual average increase of 12.43% in employment over 2008 mining employment The addition of mining employment opportunities to overall employment in the study area would represent a 0.05% increase over 2008 employment in the five-county area. Impacts resulting from Alternative A on mining sector employment is discussed below under Employment, Personal Income, and Unemployment.*Comment: Numbers for jobs as stated in the EIS are apparently the number of jobs multiplied by years. This is confusing, and tends to conceal the fact that the number of jobs is significantly under estimated. The discussion does not specify the average annual wage used to derive the numbers. Back calculations suggest that the wages used in the calculations are significantly below mining sector wages, and the wages presently being paid at the Arizona 1 Mine. This section is confusing, either intentionally or ill-prepared. It does not show how the numbers were arrived at, and does not show the basic starting assumptions. This section needs to be clarified and rewritten by stating how many individuals would be employed, and what the pay range per individual would be. The current miners at Arizona 1 make $60,000-$70,000 per year, and supervisory personnel earn more. Exploration employees for all companies earn a comparable wage. It can be assumed that all companies mining uranium on the Arizona Strip would be competitive. Wages in some peripheral jobs would be similar, while other peripheral jobs would pay less. Though this report does not include an itemization of the number of employees needed for a mining operation, the following will help you to correct that understatement of numbers. A minimum of 200 direct employees, including miners and other mine personnel, exploration personnel, office staff, and permitting and PR people would be required to develop, operate, and reclaim the 6 mines which would all be in some phase of their cycle at anyone time. An additional 600 to 800 people would be employed in mining support jobs. These jobs would continue throughout the projected 40 year mining period. Tax revenue and other benefits of the above number of jobs and wages need to be recalculated to correspond to the actual number of people employed.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
American Clean Energy	225256	114	Page 4-250 White Mesa Mill Statement: Indirect impacts are unlikely to affect the White Mesa uranium mill in Blanding, Utah. According to the	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Resources Trust (ACERT)			Denison website, the mill employs 152 people and is licensed to process an average of 2,000 tons of ore per day and produce approximately 8.0 million pounds of U308 per year (Denison 2010b). Of those 152 employees, 130 specifically work with uranium ore while the remainder work in vanadium production (personal communication, Harold Roberts, July 15, 2010). Currently, the mill is operating at 50% capacity. Regardless of the amount of uranium ore to be processed, approximately 130 people are needed to operate the mill, so regardless of the alternative, no impacts to the mill are anticipated. Comment: The EIS says the White Mesa Mill is operating at 50% capacity, and that additional ore from the northern Arizona would have no effect on the number of people employed. This is absolutely not true. When the mill runs out of ore it is shut down and all but about 20 of the 152 employees are laid off until enough ore can be stockpiled to start up again. Thus going from 50% capacity to 100% capacity would increase annual employment at the mill by 87%. It is important that this error in the EIS be corrected. Of further interest is the fact that 60% of the employees at the White Mesa Mill are members of the Navajo Tribe, and all 6 of the shift bosses are Navajos (personal communication with Harold Roberts, CEO of Dennison Mines). Thus, the northern Arizona uranium industry is providing a significant number of high-paying jobs for a minority group with chronic high unemployment. If the uranium industry were allowed to proceed, many more minority group individuals would be employed. This should be brought out in the EIS.	and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS. The revised economic analysis includes milling activity and reflects variability in milling employment based on uranium mine output.
American Clean Energy Resources Trust (ACERT)	225256	115	Page 4-250 Shootaring Canyon Uranium Mill Statement: none. Comment: No mention is made of the Shootaring Canyon Mill owned by Uranium One, located southeast of Hanksville, Utah . If uranium were being produced in northern Arizona under Alternative A, a significant amount of ore would definitely be processed in this mill, resulting in approximately 100 direct jobs and 300-400 peripheral jobs.	Please note that alternate mill locations besides the White Mesa Mill in Blanding was an issue eliminated from detailed analysis, as described in Section 1.5.3.
American Clean Energy Resources Trust (ACERT)	225256	116	Page 4-250 Pinon Ridge Mill Statement: none. Comment: The Pinon Ridge Uranium Mill near Naturita, CO is presently in the permitting phase, with some of the key permits already approved. It is likely that the mill will be completed within the next several years. If so, it is very likely that some ore from northern Arizona would be shipped there, and the amount of ore shipped will obviously influence employment at that mill. This should be also reflected in the EIS.	Please note that alternate mill locations besides the White Mesa Mill in Blanding was an issue eliminated from detailed analysis, as described in Section 1.5.3.
American Clean Energy Resources Trust (ACERT)	225256	117	Pages 4-252, 4-253 Statement: *In 2008, the worldwide market demand for uranium for the purposes of power generation was 114 million pounds, with annual demand expected to increase to 170 million pounds by 2030 (American Clean Energies Trust 2009). Under Alternative A, assuming that 2010 demand is the same for 2008, approximately 63.98% of uranium from the proposed withdrawal area could be used to meet this demand in 2010, and 42.91% in 2030.* Comment: While you can use the 2008 figure for uranium demand, there are a myriad of websites that can give a current	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			projection of the demands for uranium for power generation. One such site www.uraniumproducersamerica.com states: "The 20% of America's electricity that is currently supplied by nuclear power requires about 57 million pounds of uranium each year; yet America's uranium industry produced only 2.6 million pounds U308 in 2005(4.2 million pounds in 2010). For more than 20 years demand (i.e., consumption) has exceeded primary supply. This trend is expected to continue for at least the next decade, making it imperative to find new sources of primary supply. For more than 20 years demand (i.e., consumption) has exceeded primary supply. This trend is expected to continue for at least the next decade, making it imperative to find new sources of primary supply. Over the next 10 years there is still a significant difference between known supply and demand for uranium - a gap. This supply shortfall amounts to almost 400 million pounds or 23% of western demand over this period. New production is expected to fill a significant portion of this gap (perhaps as much as 16% of total western demand), however this is by no means guaranteed. New production will be subject to many regulatory, technical and political issues, all of which will require time and money to resolve before this production will be available to the market. Even assuming the currently-known "best case scenario" for anticipated production, the market is still "short" 100 million pounds over the next decade. This potential shortage is the primary reason why the UPA has urged the Secretary of Energy not to sell any more DOE uranium, but instead hold these inventories as an emergency reserve for national energy security." (http://www.uraniumproducersamerica.com/supply.html) Using your assumption of a 2010 need of 114 million pounds of uranium, it appears that you have incorrectly stated that "approximately 63.98% of uranium from the proposed withdrawal area could be used to meet this demand .... n The accurate statement should read that "the uranium from the withdrawal area could meet 63.98% of this demand." The same applies to the 2030 demand. 42.91% of the uranium in the withdrawal area would not be used to meet the demand. The uranium from the withdrawal area could meet 42.91 % of the demand in 2030. Lastly, the name of your resource is incorrect. The correct name that you could have easily copied from the website is American Clean Energy Resources Trust.	
American Clean Energy Resources Trust (ACERT)	225256	118	Pages 4-252, 4-253 Statement: *The current price of uranium per pound is roughly $40. Provided that demands for uranium remain constant, mining under Alternative A would likely produce approximately 33,155 tons, or 72.9 million pounds, of uranium totaling $2.9 billion in estimated value (using the 2008 value of $40 per pound). The forecast of future trends in national and world energy markets is subject to speculation and is subsequently unpredictable.* Comment: The publication date of this DEIS was February 18, 2011 . Your statement that the "current price of uranium per pound is roughly $40" is incorrect. It is not difficult to get the current price for uranium. The following chart will give you better numbers. Please	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			correct this lack of current research done by your preparers. You have used an assumption that 33,155 "TONS" of uranium would be produced under Alternative A. In your conversion to pounds it appears that you have used not Imperial Tons (2000) lbs which would have made it 66,310,000 pounds, but metric tonnes which created the number of "72.9 million pounds". If you state TONS, then use the correct measure. If you are going to use TONNES, please indicate such in your report. Thus, using the standard measure of 2000 pounds X 33,155 tons to equal 66,310,000, your estimated value would not be "$2.9 billion" as you claim, but rather $2,652,400,000.00.	
American Clean Energy Resources Trust (ACERT)	225256	138	The economic benefit of Energy Fuels mining activities is demonstrated in the table below. Again, nothing was mentioned about EFN's past economic significance to the local communities, region, state and country. This should definitely have been a part of your economic analysis. ECONOMIC IMPACT OF URANIUM MINING OPERATIONS ON THE ARIZONA STRIP The Arizona Strip historically represents some of the highest grade mineralization and most profitable per pound uranium production in the United States. During the period of 1980 to 1990, Energy Fuels Nuclear Inc. (Energy Fuels), a private Denver, Colorado-based company, produced in excess of 19 million pounds of uranium, averaging 0.65% U308 from seven mines in the northern district. With the operation and exploration offices located near the Arizona/Utah line, the Energy Fuels operations employed approximately 200 people who lived with their families in the communities of Kanab, Utah and Fredonia, Arizona. The Energy Fuels staff included 75 people working on the mining operations and 25 people in management and exploration. Table 1 calculates an approximate direct impact total of $412 million that Energy Fuels operations had on Kanab and Fredonia economies during the 1990s. The table also gives an estimate what this impact would be in Consumer Price Index (CPI) inflation adjusted dollars for a similar investment in 2008 dollars.	Appendix B of the DEIS described historical uranium mining activity in the study area. Section 3.17 of the FEIS provides further discussion of the historic economic contribution of mining in the study area.
American Clean Energy Resources Trust (ACERT)	225256	139	The table does not show the indirect impact of the jobs created by the numerous services provided by the local communities. An early estimate uses a multiplier of 4 times the direct impact, but the impact of possible future operations is beyond the scope of this report. Prior to the price decline of the 1990's, the breccia pipe uranium mines were some of last hard rock uranium producers in the US. The total amount of mineable uranium discovered to date in breccia pipes in northern Arizona is estimated to be in the range of 40 million pounds. The US Geological Survey estimates the lands proposed to be withdrawn from mineral entry in the Arizona Strip district contain a total uranium endowment of 375 million lbs. U308. Table 2 uses a calculated average of the Energy Fuels economic impact per million lbs of U308 production to calculate a total potential economic impact of $13.3 billion that will be destroyed through passage of the proposed legislation. ***see submittal # 225256 pg 94 for**	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			detailed take information	
Energy Fuels Resources	225260	31	Section 4.16.2: The first paragraph on page 4-250 does not take into account that the mill may need to shut down as described immediately above. The statement in the second full paragraph of page 4-253 that uranium is a fungible commodity and therefore its production in the U.S. would not assist us in obtaining energy independence is misleading. With so much of the worldwide production of uranium coming from countries that are antithetical to our interests, domestic uranium production will provide our country with a secure supply should uranium imports into the U.S. be restricted in the future.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS. The revised economic analysis includes milling activity and reflects variability in milling employment based on uranium mine output.
Uranium Watch	225262	3	The EIS should include an assessment of other potential uranium resources in the United States that could be developed to satisfy any need for uranium in the United States. The EIS must not ignore the fact that there are many areas in the U.S. that can supply uranium, not just the area proposed for withdrawal.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.
Uranium Watch	225262	4	The EIS should include data and information on the amount of federal funds that have been spent on the development of uranium mining in northern Arizona. This would include, but not be limited to: geological studies, uranium resource exploration, road building, reclamation and cleanup of past mining operations and impacts, reclamation and cleanup of past uranium recovery operations associated with the processing of uranium ore from public lands (including tribal lands) in northern Arizona, compensation of uranium mine and mill workers and their family under federal compensation programs, reports and studies, and projected costs for on-going and future clean up of past uranium mining and milling operations on federally administered lands in northern Arizona. The public and the federal agencies should have a clear picture of the amount of public money that has been spent in support of uranium mining and milling operation, cleanup and reclamation, compensation, and other actions associated with the development of the uranium mining and milling industry in northern Arizona since its inception.	Within the Proposed Withdrawal area, the categories of expenditures identified in this comment have been primarily funded by private companies rather than the federal government. To the extent that any of these expenditures were funded by the federal government, those historic expenditures are not relevant to the comparative evaluation of future alternatives in the EIS.
Arizona Mining Association	225266	5	Contrary to the Ninth Circuit Court of Appeals in Lords Council v. McNeil, 537 F.3d. 981 (9th Cir. En banc 2008) (finding that the law does not allow the abandonment of a balance of harms analysis just because an environmental injury is an issue), the economic impact of the proposed withdrawal has not been adequately addressed in the DEIS. In particular, the economic impact associated with not developing uranium reserves on the economies of Arizona, Utah and the nation need to be evaluated. Since the revival of the uranium industry in 2004, at least $30 million has been added to the Arizona economy and that industry was poised to add $1 billion over the next several years and over $10 billion long-term with the increased interest in nuclear energy. The industry also would add hundreds of jobs at salary levels more than 50% higher than the average	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			salary levels in the area. Instead, under the Proposed Action, there would likely be a loss of jobs in the area during a time when jobs are desperately needed. Therefore, land management agencies need to balance the environmental analysis in the NEPA process by giving equal consideration to economic and social factors and not presume that environmental harm will outweigh all other considerations.	
Western Business Roundtable	225271	3	This withdrawal is not just about lands in Arizona. It has profound implications for the nation's economic and energy security. Three facts are worth emphasizing: Nuclear power currently accounts for approximately 20 percent of the nation's electrical production (zero-emissions power, we might add). The United States currently imports 90 percent of the uranium necessary to power those plants. The U.S. Geological Survey estimates that the Arizona Strip holds 42 percent of the United States' undiscovered uranium endowment (the equivalent of 13 billion barrels of oil).	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.
Pew Environment Group	225274	19	According to the industry-provided data in the DEIS, the job creation potential of new mining operations is modest at best projected at only 75 employees per mine, not per year but per each mine's lifetime. Roughly half of those employees are predicted to come from the local areas, but specialists and higher paid employees may be among those that come from outside of the area. No consideration is given in the assessment to the sensitivity of mining employment to price swings or the well-documented boom-andbust cycle of hardrock mining operations and the clear possibilities for long shut-down periods, with only skeleton crews to oversee shuttered mines.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS. Section 4.17 of the FEIS describes the potential economic ramifications of alternative uranium price scenarios.
Pew Environment Group	225274	20	The DEIS offers a broad and overly optimistic conclusion that mine operations will not affect recreation and tourism-based jobs in the region. Again, we believe that this is not a realistic assessment, since vistas may be marred by drill rigs, power lines and other industrial architecture, visibility impaired due to mine operations and truck trips, and hunting and fishing opportunities disrupted by possible declines in wildlife species and access limitations imposed on currently open public lands. Any contamination associated with mining, such as that found near the abandoned Orphan Mine or Hack Canyon, would also impact hiking and other outdoor recreation opportunities.	The basis for the assessment that total visitor use in the region would not be noticeably affected under any of the alternatives is described in Section 4.15.3, Impacts to Visitor Use.
Pew Environment Group	225274	21	According to a 2005 economic analysis prepared by the Arizona Hospitality Research and Resource Center of Northern Arizona University, the direct yearly employment associated with Grand Canyon National Park travel was more than 9,000 direct jobs per year. It should be noted that that same study found that Park visitors strongly supported protecting the Park's natural resources, identifying the following as the most important Park resources: clean water; clean air; native plants and animals, including endangered species; and natural quiet—all of which could be impacted by mine operations Arizona Hospitality Research and Resource Center,	The study team has reviewed the reference cited. Section 3.17 of the FEIS describes the economic contribution of the Grand Canyon and other NPS-managed lands in the study area.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Northern Arizona University, Grand Canyon National Park, Northern Arizona Tourism Study, April 2005, http://www.nau.edu/hrm/ahrrc/reports/Grand%20Canyon%20Comprehensive%20Final%20Report.pdf.	
Northwest Mining Association	225275	3	The BLM needs to consider the environmental impacts of not developing the uranium resource in this area. If these breccia pipes are not developed, we must obtain uranium from some other country which may not be friendly to the interests of the United States. Alternatives B, C, and D will increase the United States' reliance on foreign sources of this critical and strategic mineral while adversely impacting our balance of payments.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.
Northwest Mining Association	225275	4	The U.S. currently gets 20% of our electrical energy production from nuclear energy. It is critical that we have a secure domestic supply of the uranium needed for nuclear generating stations. We already are importing over 90% of our needed uranium. According to USGS Report C.1051, the Arizona Strip holds 42% of the nation's estimated undiscovered uranium endowment. This is the equivalent of 13 billion barrels of oil. To withdraw this critical resource from location and entry under the Mining Law, with no environmental benefit or necessity, is illogical, short-sighted and dangerous.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.
Northwest Mining Association	225275	7	The economic impact of the proposed withdrawal must be considered. Obviously, the economic impact from the job losses in northern Arizona and southern Utah would be significant. Since the revival of the uranium industry in 2004, at least $30 million has been added to the Arizona economy. According to an economic study recently completed, the industry was set to invest more than $1 billion over the next several years and over $10 billion during the anticipated longterm healthy uranium market due to renewed interest in nuclear energy. The industry would add hundreds of jobs at salary levels 50% higher than the current average in the area, at a time when those jobs are desperately needed.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	42	Based on an independent peer review of potential economic impacts on mining from a withdrawal, the economic benefits attributed to mining in the DEIS are baseless. The peer review report provides the following assessment: Throughout the DEIS, we note a variety of inconsistencies in the use of data and inaccuracies in modeling the economic impact of the withdrawal that cause us to seriously question the veracity of the final conclusions related to the four withdrawal alternatives. Most of our concerns fall under questioning of the methodology of the economic impact analysis and its assumptions. The analysis presented in the DEIS related to the economic impact of uranium mining in northern Arizona contains errors in inputs and assumptions as well as interpretation of the economic output and value added of mining activities. These errors demonstrate a serious misunderstanding of economic impact theory on the part of the authors. We question the assumption for the average uranium	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			ore body per mine of 3 million pounds or 1,500 tons of U3O8. This assumption is more than twice the expected output from existing mines that are currently in production or permitted and planned for production in the near future. It is a fundamental assumption that is used throughout the economic analysis. The economic impact analysis of uranium mining extends well beyond the two counties in Arizona. If the DEIS is to evaluate the impact of mining on northern Arizona, there is little need to extend the impact to the distant San Juan County, Utah where processing of the uranium ore will occur. That processing operation is wholly separate from the mining of the ore and does not impact northern Arizona. By including the uranium processing operation in Blanding, Utah in the economic impact assessment on northern Arizona, the economic impact of mining is greatly expanded in the report and could mislead lay persons on the true impact of uranium mining in northern Arizona. In addition, any profits related to the sale of yellow cake will flow out of the U.S. to the Canadian company that operates the Blanding, Utah mill and its shareholders. This fact is not addressed anywhere in the DEIS. The economic impact of mining in northern Arizona should be based on the value of the ore as it is extracted from the ground and transported to Utah. We would recommend that the DEIS address this issue which would permit the development of estimates of the economic impact of uranium mining on northern Arizona. The Final Environmental Impact Statement should include a careful response to Rick Merritt's full report. The full report is provided in Attachment 2 to our comments. It was written by Rick Merritt, President of Elliott D. Pollack & Company. Mr. Merritt is coauthor of the Arizona Statewide Economic Study that established an economic development strategy for the State of Arizona and its regions. Mr. Merritt and associates of the firm have produced a number of economic impact reports for private clients on mining in Arizona.	
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	60	The economic impact analysis of uranium mining extends well beyond the two counties in Arizona. If the DEIS is to evaluate the impact of mining on northern Arizona, here is little need to extend the impact to the distant San Juan County, Utah where processing of the uranium ore will occur. That processing operation is wholly separate from the mining of the ore and does not impact northern Arizona.	As discussed in Section 3.16, the study area for the social and economic analysis was defined to include the counties and communities most likely to be substantially affected by the alternatives, including counties and communities in southern Utah.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon	225279	61	In addition, any profits related to the sale of yellow cake will flow out of the U.s. to the Canadian company that operates the Blanding, Utah mill and its shareholders. This fact is not addressed anywhere in the DEIS.	The revised analysis of the economic impact of the alternatives provided in Section 4.17 of the FEIS provides a clearer discussion of the contribution of milling and hauling to the economic value added in uranium extraction and the distribution of uranium revenues among these stages of production. Profit is

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Chapter, Center for Biological Diversity				cost of capital, the required return on invested capital. For any profit to remain in the study area the owners of that capital would have to reinvest it within the study area. That would go for tourist industry investments as well as mining. Given that capital is fungible it does not matter where profits initially flow – if the study area has the right opportunities capital will flow in.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	62	The economic impact of mining in northern Arizona should be based on the value of the ore as it is extracted from the ground and transported to Utah. We would recommend that the DEIS address this issue which would permit the development of estimates of the economic impact of uranium mining on northern Arizona.	As discussed in Section 3.16, the study area for the social and economic analysis was defined to include the counties and communities most likely to be substantially affected by the alternatives, including counties and communities in southern Utah.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	67	We question why the economic impact analysis considers the impact of uranium mining on five counties in Arizona and Utah when all mining activities will be conducted in just two Arizona counties: Coconino and Mohave. While there certainly will be employment and spending impacts on nearby Utah communities in Washington and Kane Counties related to the North and East Parcels, the much more distant San Juan County will have few direct impacts except for the fact that the uranium ore will be processed in Blanding, Utah at Denison Mines' White Mesa Mill. However, that processing operation is wholly separate from the mining of the ore. If the BLM truly desires to evaluate the impact of mining on northern Arizona, then the economic impact analysis should be focused on the mining activities that occur only in Arizona. Virtually all environmental assessments of the impact of mining in the DEIS focus just on Arizona, not Utah. The economic impact assessment should be conducted in a similar manner.	As discussed in Section 3.16, the study area for the social and economic analysis was defined to include the counties and communities most likely to be substantially affected by the alternatives, including counties and communities in southern Utah.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	68	However, the yellow cake is processed in Utah, not Arizona, and is sold out of Utah by Denison Mines, a Canadian company. The economic impact of the processing operation benefits Utah, particularly San Juan County, and not Arizona. In addition, any profits related to the sale of yellow cake will flow out of the U.S. to the Canadian company and its shareholders. This fact is not addressed anywhere in the DEIS.	As discussed in Section 3.16, the study area for the social and economic analysis was defined to include the counties and communities most likely to be substantially affected by the alternatives, including counties and communities in southern Utah. The revised analysis of the economic impact of the alternatives provided in Section 4.17 of the FEIS provides a clearer discussion of the contribution of milling and hauling to the economic value added in uranium extraction and the distribution of uranium revenues among these stages of production.
Grand Canyon	225279	69	Instead, the economic impact of mining in northern Arizona should be	As discussed in Section 3.16, the study area for the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity			based on the value of the ore as it is extracted from the ground and transported to Utah. Clearly there is a value to be placed on this ore and, in fact, Denison Mines' White Mesa Plant is purchasing ore from mines in northern Arizona controlled by independent parties. Denison Mines' Independent Miner - Ore Schedule of February 1,2011 for Arizona Strip uranium ore provides pricing for a ton of ore ranging from $227.50 per ton with a uranium grade of 0.34% to $966.08 per ton with a uranium grade of 1.05% (based on a uranium sales value of $73 per pound). Assuming the grade of the ore averages 0.60%, the mining and hauling operation would account for approximately 60% of the value of the finished uranium yellow cake. At a price of $62.50 per pound (the average price of uranium yellow cake in January 2011), the uranium ore would be worth approximately 57% of the value of yellow cake (uranium spot price hit low of $53 on 3/18 and as of 3/21 was $60.	social and economic analysis was defined to include the counties and communities most likely to be substantially affected by the alternatives, including counties and communities in southern Utah. The revised analysis of the economic impact of the alternatives provided in Section 4.17 of the FEIS provides a clearer discussion of the contribution of milling and hauling to the economic value added in uranium extraction and the distribution of uranium revenues among these stages of production.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	70	A second source of information was found in a technical report prepared by Scott Wilson, an engineering firm that is now part of URS Corporation. The report entitled "Technical Report on the EZI and EZ2 Breccia Pipes, Arizona Strip District, U.S.A." was prepared for Denison Mines Corporation and downloaded from their website. The table references historic operating costs from the late 1990s. While dated the informatio . dicates that mining and transportation represents about 58% of total operating costs. This source could be used to address the value of output om uranium mines in northern Arizona.	The revised analysis of the economic impact of the alternatives provided in Section 4.17 of the FEIS provides a clearer discussion of the contribution of milling and hauling to the economic value added in uranium extraction and the distribution of uranium revenues among these stages of production.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	71	Table 3.16-21 on page 3-276 estimates the value of estimated total available uranium resources in the proposed withdrawal area at $2,917,640,000 based on 33,155 tons ofU308 at $40 per pound. Based on information available, a portion of this value, perhaps 55% to 60%, is related to the value of the raw ore delivered to Blanding, Utah. At a price of $40 per pound for yellow cake, $22 to $24 per pound may be related to the value of the raw ore. This value establishes the ultimate output of the northern Arizona mining operation and is the basis for modeling the economic impact. * See submittal 225279 for detailed tables	As discussed in Section 3.16, the study area for the social and economic analysis was defined to include the counties and communities most likely to be substantially affected by the alternatives, including counties and communities in southern Utah. The revised analysis of the economic impact of the alternatives provided in Section 4.17 of the FEIS provides a clearer discussion of the contribution of milling and hauling to the economic value added in uranium extraction and the distribution of uranium revenues among these stages of production.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	72	Page 3-251: The authors use Bureau of Economic Analysis (BEA) data for evaluation of employment related to mining and tourism. While the data is useful in certain analyses, it is not current and is only available through 2009. Employment data available from the Bureau of Labor Statistics (BLS) is current on a monthly basis and provides a more realistic picture of employment trends. BLS data is the most widely referenced by the media since it estimates job gains and losses on a monthly basis. BEA data, alternatively, includes both full-time and part-time jobs as well as double counting of jobs for those persons with two jobs. As a result, BEA employment data is upwards of 1I3rd higher than BLS data. While a small	Different agencies count jobs (or employed persons) in different ways, including different treatment of part-time positions, self-employed individuals and other issues. The table discussed in this comment reflects data published by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). BEA data was used to describe existing employment because it provides consistency across sectors, time periods and among different counties. BEA data also provides a more comprehensive tabulation of employment

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			issue, we believe BLS data should be used as well in the analysis.	(including positions not covered by unemployment insurance) than other sources such as Bureau of Labor Statistics (BLS) data.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	73	Pages 4-245 and 4-246 do not identify the economic impact mUltipliers used in the analysis nor the year in which the dollars are stated (such as, for instance, constant 2008 or inflated dollars). The value of uranium is not identified nor how the wages of mining employees are calculated. While IMPLAN is identified as the input/output modeling system, the inputs to the system are not identified in the chapter.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	74	Under Section 4.16.2 Impacts of Alternative A: No Action, employment per mine is incorrectly stated as 75 employees per mine based on seven years of planning and permitting, mine development, mine production, and reclamation with a maximum of six mines operating at one time. Employment in economic impact analysis is typically based on person-years of employment. In actuality, each mine will have 200 person-years of employment over seven years or an average of28.6 employees per year. This miscalculation of mining employment is the most serious error in the economic impact analysis and calls into question the accuracy of the conclusions of all four withdrawal alternatives. The authors of the impact analysis also indicate that direct employment under Alternative A over 20 years is 2,250 employees or 112 per year This calculation is in error. Actual direct employment under the assumptions, in fact, totals 5,855 person-years over 20 years or an average of 308 direct jobs per year. With these miscalculations, the direct, indirect and induced employment and output of the mining operation outlined in this section are in error.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	75	The text related to Table 4.16-3 states a total of $5.46 billion in value added and output related to uranium mining, comprised of $2.06 billion in value added and $3.39 billion in output. According to IMPLAN and economic theory, value added is a part of output and the two values cannot be added together to arrive at a total estimated impact. Following are the definitions from IMPLAN. Value Added: The difference between an industry's or an establishments total output and the cost of its intermediate inputs. It equals gross output (sales or receipts and other operating income, plus inventory change) minus intermediate inputs (consumption of goods and services purchased from other industries or imported). Output: Output represents the value of industry production. In IMPLAN these are annual production estimates for the year of the data set and are in producer prices. For manufacturers this would be sales plus/minus change in inventory. * See submittal 225279 for detailed tables	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Grand Canyon	225279	76	The inputs to Table 4.16-3 are not identified in the DEIS. We are not able	The discussion of the economic effects of mining

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity			to analyze the table due to the lack of identification of inputs and the errors noted above. The same situation applies to Table 4.16-4.	under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	77	Even in the event that Table 4.16-3 was accurate, the output of $3.39 billion is higher than the value of estimated total available uranium resources in the proposed withdrawal area of $2.92 billion based on 33,155 tons of U308 at $40 per pound (see Comment 2 of this report related to Table 3.16-21 of the DEIS Chapter 3). The value of the output of withdrawal Alternative A cannot be larger than the $2.92 billion unless some undisclosed assumptions are provided to explain how they arrived at a higher number. As noted previously, this is just one instance of the inconsistency in the data presented in the economic impact analysis of the DEIS.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
National Mining Association	225281	6	The wide-ranging consequences of the withdrawal have not been adequately assessed in the DEIS, particularly potential implications for national economic or energy security. The Mineral Report prepared in conjunction with the DEIS accurately notes that "failure to develop uranium resources on the subject lands that have the potential of becoming the second most important uranium-producing region in the United States has far reaching economic implications," but concludes that those implications are "beyond the scope of this report." Mineral Report at p. 23. The Mineral Report may not be the appropriate vehicle for addressing such implications but certainly the Socioeconomic Report or the DEIS would be. But these documents fail to acknowledge the implications to our national economic and energy security. Instead, the Socioeconomic Report and DEIS dismiss the potential benefits of mining domestic sources of uranium with statements such as: Like oil and lumber, uranium mined in the United States can be sold to consumers domestically or abroad, based on demand and subsequent market prices. Currently, there are no laws in place that would require domestic uranium to be solely purchased and consumed within the United States. As a result, uranium mined and produced in the United States would not necessarily move the United States toward energy independence. [and thus would not represent an impact to national energy resources] DEIS at 4-253. Socioeconomic Report at 39 and DEIS at 3-276. Such a statement is without merit. There are many commodities from agricultural to livestock to oil that are sold on the global market but that are still important to develop domestically in order to further our national and economic security.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS. Note, however, that the role of nuclear energy in the nation's energy future was an issue eliminated from further analysis as discussed in Section 1.5.3.
National Mining	225281	7	The dismissiveness of the DEIS regarding the ability of domestic uranium	A revised discussion of uranium supply and demand

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Association			to assist in achieving the U.S.' energy independence goals ignores how development of domestic uranium promotes economic and energy security. The U.S. has the world's largest fleet of nuclear reactors (now 104), which produce nearly 20 percent of our country's electricity. The U.S. has one of the world's largest resource bases of uranium of any country in the world and as noted in the DEIS, some of the richest uranium deposits in the U.S. are in the proposed withdrawal area. Despite these resources and the size of our nuclear fleet, however, the U.S. produces less than 10 percent of its own uranium and imports over 90 percent of what is needed to operate our reactors. At a time when energy costs are rising and all available sources of energy must be utilized to meet increased demand, preventing access to the resources to provide such energy is bad public policy, especially when such actions are unnecessary to provide effective protection of the environment and special places like the GCNP.	and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS. Note, however, that the role of nuclear energy in the nation's energy future was an issue eliminated from further analysis as discussed in Section 1.5.3.
Northwest Mining Association	225275	8	Another economic consideration is the cost to the government, i.e., U.S. taxpayers, of the proposed withdrawal. Federal law provides that prospectors and miners have a statutory right to locate mining claims for exploration, development and production of minerals. Mining claims in good standing provide these miners with vested property rights, and blocking such rights would likely subject the United States to substantial takings litigation. Furthermore, the land management agencies clearly do not have the funding and resources required to perform in a timely manner the mineral examinations required under a withdrawal scenario.	A property right is only conveyed to the mining claimant if the claim is valid. Within a withdrawal, validity of claims are determined through mineral examination. Mineral examinations are paid for by the mine proponent, so there will be no additional cost to the Federal Government.
Northwest Mining Association	225275	9	Furthermore, it is incumbent on Federal land management agencies, when balancing the environmental analysis during the NEPA process, to give equal consideration to the social and economic factors and not presume that environmental harm will outweigh all other considerations. Accordingly, the ninth circuit court of appeals in Lands Council v. McNair, 537 F.3d 981 (9th cir. en banc 2008), stated: "Our law does not allow us to abandon a balance of harms analysis just because an environmental injury is at issue. As we have articulated above, there is no environmental injury at issue in this case, as current Federal and state environmental laws and regulations provide sufficient authorities and tools for the protection of all resources while providing for multiple-use of the area." Therefore, the BLM must give significant weight to the adverse economic harm resulting from a mineral withdrawal in northern Arizona. Given the current state of the U.S. economy, it is more important than ever to adhere to the statutory	The EIS analysis has considered all the factors required for environmental review and followed all appropriate policies and regulations in doing so.
National Mining Association	225281	10	If the DEIS underestimates the amount of uranium that can be recovered from the proposed withdrawal area, it similarly underestimates the potential economic benefits of uranium mining. As noted in the Socioeconomic Report, the proposed withdrawal area has suffered during the recent recession, "Arizona has been hard hit by the recent national economic downturn, leading the nation in job losses and housing foreclosures." Socioeconomic Report, p. 14. The current precarious	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			economic situation only highlights the need to carefully consider a withdrawal that puts at risk hundreds of high-paying mining jobs-with an average annual wage of $59,000, 33 percent higher than the combined annual average for all industrial jobs-in Arizona, and Utah. The difference in wages is magnified when one examines the average wages in the counties that would be impacted by the withdrawal since these counties generally lag behind the average state wage. See Socioeconomic Report at p. 20 (2007 wages for Mohave and Coconino Counties lag behind the Arizona average wage of $42,214 at $35,123 and $32,135 respectively; and Socioeconomic Report at p. 22 (2007 wages for Kane, San Juan and Washington Counties lag behind the Utah average wage of $37,722, at $26,836, $29,212 and $30,310 respectively.) Obviously, the high-paying mining jobs would be a boon to these counties. And while many of the commenters during the scoping period may claim otherwise, tourism jobs cannot compete with mining jobs. As accurately portrayed in the Socioeconomic Report, "tourism related jobs are often seasonal, require unskilled labor, and provide low income. These jobs are often part-time jobs and do not provide insurance benefits." Socioeconomic Report, p. 24.	
Ted Jensen	225282	2	Many good people honestly invested extensive time and money into their claims. Liability precedence exists for compensation of proven damages. Direct liability damages will be in the hundreds of millions of dollars and indirect damages will further magnify the liability. These costs need to be included in the alternatives.	Existing claims determined to be valid through a validity examination would be allowed to move forward under any of the alternatives. See PL 94-579 Sec. 701 (Federal Land Policy Management Act).
Ted Jensen	225282	6	Impacts on economic conditions appears incomplete or inaccurate. On page 4-240 it states that there will be no impact on jobs or population in Fredonia. How was this statement of opinion incorporated? Within your study it states that Coconino County has witnessed a 20% growth but Fredonia has a negative 14.2% growth rate. Note this an effective difference of 34.2% as compared to the rest of Coconino County. The town of Fredonia has lost its logging industry, tourist activity is being further restricted, ranching all but stopped, and other agendas are slowly killing this town. The loss of even one more job may tip this town over. To discount the economic impact is wrong. In turn, economic impacts are not carried into the Executive Summary section. One of the most important categories involving people is inappropriately discounted as "no impact."	The discussion and analysis of demographic impacts of the alternatives has been revised in Section 4.16 of the FEIS.
Ted Jensen	225282	18	Statements regarding economic impacts fail to fully look at how vulnerable Fredonia, Paiute Tribe, and other low income communities are to complete failure. The negative growth rate combined with withdrawal of all mining may destroy this area. Logging and ranching have all but been stopped due to other environmental good intentions. Please note that tourist business is very weak and the most important tourist draw, the Grand Canyon North Rim is closed for fifty percent of the year (October to May 15).	The discussion and analysis of demographic impacts of the alternatives has been revised in Section 4.16 of the FEIS. Disadvantaged communities are discussed in the environmental justice portions of Section 3.16 and 4.16.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Doug Reagan	242175	2	The economic justification for not withdrawing lands at this time is incomplete to the point of being inadequate; it does not include the value of tourism, aesthetics, or existence value of the resources that would be affected by exploration and mining (e.g., roads, drill sites).	The economic value of tourism and recreation, including existence values, is discussed in Section 3.17 and 4.17 under the heading "Recreation and Environmental Economics."
Maren Mahoney	226214	3	Under the economic analysis, the EIS failed to consider the negative impacts to the economy in both the local area and the entire state of Arizona. Mineral development might lead to economic gains for mining companies and some of their employees, but it is unclear where the majority of the economic gains will go.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.16 of the FEIS.
Maren Mahoney	226214	5	The EIS fails to take into account time scales when analyzing economic impacts of tourism-related industry and mining-related industry and economic generation. Mining is a finite industry dependent almost completely on the quantity of mineral resources. Once the mineral source has been exhausted, the mining industry packs up and leaves the region (see, for example, Tombstone). Tourism, on the other hand, has the potential to dramatically expand and empower local economies. However, this depends on the long-term protection of the natural resources, not the short-term extraction of those resources. By failing to consider time scales on economic impact, the analysis is flawed.	The EIS has a time horizon of 20 years, consistent with the definition of the proposed action and alternatives.
Kate Johnston	226267	2	I question the utility of the DEIS in toto. Additionally, the pricing supplied in the DEIS is for yellowcake, which is not the raw ore being sold to the processor in Utah. The yellowcake price outstrips the raw ore price, making the DEIS estimates flawed and not indicative of the profitability of the proposed mines.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Kate Johnston	226267	4	The DEIS misuses economic theory and disregards IMPLAN by combining value added and output in order to come up with a favorable number. This is in opposition to best practices by the industry, not to mention the government. Therefore this DEIS is flawed and unacceptable and at the very least another DEIS should be performed which does not contain the many drawbacks and obfuscations perpetrated by this DEIS.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Lela Rhodes	226422	3	The DEIS makes no mention of the economic benefit to the BLM from annual claims payments made by those US Citizens or US companies that have filed those claims. Your database lists 5207 claims within the withdrawal were renewed for 2010. At $140 per claim, the BLM received $728,980 in income. Using the 2011 claim renewal number of 3301, your income was $462,140. This economic benefit should be listed in the DEIS. Also, your plan for reimbursement of these monies should be reported in the final EIS should the decision be made to withdraw the land.	The annual fee noted assists in covering the costs that BLM incurs in administering claims. A reduced number of claims may result in corresponding reduction in BLM expenditures. Annual fees would continue to be recovered from current claim holders under all alternatives. No assumption has been made about the number of claims that might be relinquished or the number of new claims that might be filed under any of the alternatives.
Seth Cude	232398	2	Section 1-4 and 1-5: Important point missing: Change in public perception due to mining the Grand Canyon would have a very negative impact annual park visitation. The pristine untouched beauty of the park brings	The basis for the assessment that total visitor use in the region would not be noticeably affected under any of the alternatives is described in Section 4.15.3,

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			millions of visitors. If this perception is tarnished by mining park attendance and income would be greatly reduced.	Impacts to Visitor Use. No mining is currently allowed within the Grand Canyon National Park, and none will be. The degree to which tourist behaviors are affected by perceived impacts has not been studied. Any attempt to characterize these behaviors would be speculative.
VANE Minerals	242650	2	Mining companies have excellent knowledge as to where the best potential lies and therefore, the withdrawal of these lands will kill the industry as well as cause undue personal burden and hardship on families due to job loss and the loss of economic opportunity to businesses in the area. The DEIS states that the average annual wage for the tourism-related sector which is a major employer in the region is $21,230 for Arizona, and $20,200 for Utah. The US Poverty Line for a family of four in 2009 was $22,050. The mining industry represents one of the last alternative economic opportunities available on public lands in the region and a decision to withdraw these lands will help encourage a future of poverty.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
VANE Minerals	242650	7	With respect to Impacts on Economic Conditions as addressed on page ES-14 of the DEIS document, the application of simple proportional economic impacts to the various alternatives is wrong and reflects the inexperience, if not naivety, of the author. It is not simply a math problem whereby, when decreasing the area of lands open to mining, the economic benefit decreases proportionally. Any of the withdrawal alternatives (except A, no withdrawal) will likely drive companies from the district as the entire area needs to be available and open for exploration in order to have economic viability. While Alternative D might result in some continued interest, Alternative C will likely have the same impact as Alternative B (full withdrawal).	Beyond the need for a sufficient scale of regional mining to allow milling operations to continue to be viable, there is no evidence from the historical experience of the area to support the notion that all of the proposed withdrawal areas need to be fully available to make uranium exploration and production viable.
VANE Minerals	242650	8	The DEIS does not reveal that exploration is essentially dead since the segregation order was handed down, due to the use of "heavyhanded" interpretation of the "prudent man rule" in the Mining Act of 1872. And, the DEIS does not recognize that in Alternative B, upon mining out the known deposits, activity in the district will stop. Further to this, the DEIS does not disclose the economic impacts of what will happen when all activity stops. Jobs and taxes directly related to mining and indirect impacts such as income for local businesses will all end.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
VANE Minerals	242650	13	Energy Resources, page 4-253, third paragraph ... *there are no laws in place that would require domestic uranium to be solely purchased and consumed* ... and ... *uranium mined and produced from within the parcels would not necessarily move the United States toward energy independence* .This conclusion misses the point. That being, at present the United States imports 90% of the uranium it consumes for its nuclear power industry. This means that the present capacity of domestic uranium mines is 10% of the US demand. Production of uranium from the area will	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			increase domestic production so that in the event some protectionist policies are needed due to foreign instability, that production can be called upon. Uranium production (or any mined commodity) cannot be "turned on" when needed, but requires many years of lead time for exploration and mine development to come on stream. Having 100% of the US demand covered with domestiC production whether or not it is used domestically is a healthy strategic policy. One needs only to look at US oil demand and production to get the picture. Therefore, it is a fact that uranium produced from within the parcels would move the United States toward energy independence.	
Mary Crow-Costello	242652	7	Economic Impacts: The economic analyses appear to be are based on an over-simplistic model. It is stated on pg. 248 of 270: *overall regional tourist activity and associated employment are unlikely to be affected under Alternative A.* If thirty new uranium mines are constructed, the damage caused by these mines likely will be noticeable to tourists and will affect the amount of repeat visits and new visits over time as the word gets out.	The basis for the assessment that total visitor use in the region would not be noticeably affected under any of the alternatives is described in Section 4.15.3, Impacts to Visitor Use.
Mary Crow-Costello	242652	8	The mere perception of pollution, especially radioactive pollution, will deter potential new residents and business upstarts from the area. It also will likely spur an emigration from the area. Was this accounted for in the economic model?	The study area is generally sparsely populated and most or all new mines are likely to be located in essentially unpopulated areas. We are unaware of any historical information indicating that concerns regarding uranium mining or waste products have deterred residents or businesses from locating in area communities or have led to outmigration.
Arizona Rock Products Association	242654	5	The impact to the nation's nuclear fuel supply by removing between 326 - 375 million Ibs of America's highest grade uranium deposits at a time our domestic utilities are importing 90% of the uranium they use from foreign nations even though we could easily be self sufficient; and finally, why the Secretary of Energy is out promoting President Obama's agenda to build additional nuclear power plants, while the President's Secretary of the Interior is moving rapidly to block access to one of the largest domestic supplies of fuel necessary to operate new reactors , not to mention the 104 reactors now operating within the United States. There will be renewed interest in building additional nuclear power facilities to meet the needs of a growing U.S. population. These breccia pipe uranium deposits are a key part of meeting current and future demand and the Administration has done little to validate its reasons for its actions.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.16 of the FEIS. The role of nuclear energy in the nation's energy future was an issue eliminated from further analysis as discussed in Section 1.5.3.
Arizona Rock Products Association	242654	19	ARPA is also concerned that the DEIS artificially and arbitrarily reduces the size of this massive endowment, overestimates the amount of resources that could reasonably be extracted after proving Valid Existing Rights, and underestimates the loss of royalties, jobs, taxes and investments resulting from the withdrawal.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS. The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Section 4.17 of the FEIS.
Arizona Rock Products Association	242654	22	suspects that the DEIS has massively underestimated the number of mineralized breccia pipes available for development and consequently have not adequately constructed an analysis in the RFD that correctly identifies and addresses the massive financial implications of closing the withdrawal area to development. Clearly, a withdrawal would essentially destroy the entire productive potential of the highest grade and most favorable endowment of uranium mineralization in the United States.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Groundwater Awareness League, Inc	242658	5	Although at present, the ore is trucked to Blanding , UT, it is feasible if more mines were to open, the mining companies would put a milling operation in the Grand Canyon region to avoid the 250 to 300 mile trip. This heavy use of fossil fuel is one of the issues with the claim that nuclear power is clean energy. Therefore, it is essential to understand the ramifications of a milling operation. Exporting an environmental problem elsewhere is no reason to eliminate its consideration.	Potential alternate mill locations was an issue eliminated from further analysis in the EIS. Please see Section 1.5.3.
Quaterra Resources, Inc.	242664	5	Perhaps the most erroneous assumption in the DEIS is that resources of the district are not capable of sustaining mining for 20 years. At an average production of 1.5 million lbs of uranium per year per mine, an average of 3 million lbs produced per mine, and even using a gradual ramp-up of production, six continuously operating mines could produce 160.5 million lbs in 20 years; only one half the total estimated endowment of the subject lands.	As described in the Geology and Mineral Resources and Economic Conditions sections of Chapter 4, the estimated economically recoverable reserves in the proposed withdrawal areas are approximately 79.3 million pounds.
Quaterra Resources, Inc.	242664	17	Because of the errors in the time frame, the economic impact of the proposed withdrawal has been seriously underestimated. An independent report prepared by Tetra Tech in September 2009 ECONOMIC IMPACT OF URANIUM MINING ON COCONINO AND MOHAVE COUNTIES , ARIZONA (Attached) uses a six mine - 42 year scenario to model to the economic impact of producing the entire uranium endowment of the NAPWA. The report concluded that the uranium mining operations would provide a significant long-term benefit to the area, state, and region: a direct total sales impact of $18.9 billion over the 42-year duration of the project, with indirect impacts of $10.5 billion, for a total impact of $29.4 billion, resulting in an average annual impact of $700 million. During the 40 years of operation, the companies expect to employ a total of 390 workers annually; this total includes miners, geologists, engineers, managers, and other professional and support staff. These workers are projected to generate an additional 688 jobs in the region of influence for a total increase of 1,078 jobs during the years of full operation. Annual wages of $25 million would generate annual indirect impacts of $15 million, for a total of $40 million annually. A portion of these benefits would occur in neighboring Kane and San Juan Counties, Utah, where some workers would likely reside. Table 4: Estimated loss of uranium production of 6 continuously operating mines over a 20 year in the NAPWA . Ore mined	The EIS has a time horizon of 20 years consistent with the definition of the proposed action and alternatives. Please also note that the economic analysis contained in Section 4.17 has been revised for the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			from the NAPWA would be taken to the White Mesa Mill, in Blanding, Utah, for processing, and would ensure the continued operation of the mill, along with the substantial benefits it provides to San Juan County and its residents, and would improve the economic opportunities for suppliers in Blanding, the surrounding areas, and the region. Mining companies contract with trucking firms contracted by the mining companies to ship ore from mines to processors typically hire personnel and build service shops locally. Over the 42-year operating period, transporting the ore would generate about $1.6 billion in revenues for trucking firms, long-term stable employment for their workers, and a steady stream of revenue for their suppliers. Other beneficiaries include national mining equipment companies; suppliers for items such as tires; oil companies providing fuel; and a host of other firms that employ workers across the United States, in areas far removed geographically but not economically from Arizona. Federal, state, and local governments would receive a variety of tax revenues over the 42 year life of the proposed project, including corporate income taxes, severance taxes, payments to county governments, and income taxes from workers. The mining companies project payments of $2 billion in federal and state corporate income taxes and $168 million in state severance taxes over the life of the project. Local governments would receive $9.5 million in claims payments and fees. All of these payments would represent sizable benefits to the governments involved. Local property tax bases would increase as workers moved into the area and purchased homes. Existing residents would see their incomes increase with better jobs, and could purchase larger homes or improve existing ones. Local and state sales taxes would increase from purchases by the mine operators and their suppliers, by workers and their families, and by other local residents who see their incomes rise as an indirect impact of the mining operations. **(see submittal 242664 for detailed table info.**	
The NAU Project, LLC	242913	18	Impacts on Economic Conditions Alternative A would result in beneficial moderate to major long-term impacts to economic activity from mineral development because of the potential economic value of uranium mined of $2.9 billion and direct industry employment total of $613.7 million. The economic value of the uranium mined is about $139.7 billion and not $2.9 billion. The $2.9 billion dollar figure is 4817% too low. The economic value of the uranium fuel mineral for this DEIS was only calculated for the commodity value of the uranium and not its economic value as a fuel mineral. This is incorrect. A false assumption lead to the omission of an entire analysis that was required by this EIS and the NEPA process. This lack of analysis appeared to be intentional. These errors must be corrected. I have made many suggestions and analysis on how this could be done.	The economic analysis contained in Section 4.17 of the EIS reflects the projected market value of uranium. The value-added between the beneficiation of uranium at the mill and the actual production and sale of nuclear-generated electricity occurs primarily at the power plants themselves and through the distribution and sale of the electricity. This value-added is a return to electricity generation and distribution operations that are far from the study area, and would remain the same whether those plants use fuel originally mined within the proposed withdrawal area or fuel obtained from elsewhere in the U.S. or overseas.
The NAU Project, LLC	242913	19	Table 3.1-1 indicates the analysis was to be done, but it was not. For example: the Uranium in the withdrawal area is equivalent to 642 million	The economic analysis contained in Section 4.17 of the EIS reflects the projected market value of uranium.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			tons of coal. Uranium exploration and mining is projected to disturb 1364 acres of land, and coal production of 642 million tons would disturb about 25,600 acres. See my detailed analysis in my Comments for Chapter 3. A Solar comparison is easily analyzed in about 30 minutes of research and another 30 minutes to write it up. There is a concentrating solar power plant that has received approval for construction near Gila Bend, Arizona. It will be built by Crossroads Solar Energy. According to press releases and their website, the plant will produce 450,000 Mwh of electricity per year. This equates to 450 million Kilowatt-hours per year. The cost of the solar plant will projected to be $650 million and it will take up 4 sq-mi of land area. I don't have information on what its water usage will be, but I am sure that this value could be found.The uranium in the withdrawal area has an electrical generating value of 1284 Billion Kilowatt-hours and a yearly value(divide by 20) of 64.2 Billion Kilowatthours. Thus the number of solar power plants required to produce the same amount of electricity is found by: (64.2 billion kWh/yr) nuclear/ (450 million kWh/yr)Solar = 142.7 Solar Power Plants. The Cost of these new Solar Power plants would be $92.755 Billion. The land area to site these plants would be 570.8 square miles or 365,312 acres or more than 1/3 of the acres sought for withdrawal. This land would, in essence, be totally consumed as no other uses would be available. The Solar power plants have their own life cycle and would undergo periodic replacement as the mirrors will all need replacement over time. These solar power plants, due to their inherent use of large areas of land and water requirements, face their own EIS challenges as can be seen in the press. The uranium mined in the withdrawal area can be used in U.S. nuclear reactors and reduce the imports of uranium into the U.S. at no additional build out cost. See below graphic for how much land would be required to equate to the uranium electrical energy overlaid on the withdrawal map. A short analysis can be made for the other alternative energy source listed in the DEIS.The amount of land required to site a Solar power plant equal to the uranium electrical equivalent on a per year basis. This amount of land completely cover with solar collector mirrors. No other uses available.	The value-added between the beneficiation of uranium at the mill and the actual production and sale of nuclear-generated electricity occurs primarily at the power plants themselves and through the distribution and sale of the electricity. This value-added is a return to electricity generation and distribution operations that are far from the study area, and would remain the same whether those plants use fuel originally mined within the proposed withdrawal area or fuel obtained from elsewhere in the U.S. or overseas. The analysis of specific alternative energy sources was an issue eliminated from further analysis, as described in Section 1.5.3.
The NAU Project, LLC	242913	24	Table 1.5-1 Economic Conditions Energy resources available The withdrawal could lead to increased reliance on energy sources other than nuclear, such as additional mining elsewhere, imports of uranium from foreign sources, or production from equivalent amounts of other sources like coal, petroleum, natural gas, wind power, or solar. The above analyses were never done. This is a BIAS by omission in the writing of this EIS and the level of thought that went into the justification for not doing these analyses indicate that the omission was purposeful. The justification is bases on a false premise and the required analyses should be done and included in the EIS. NEPA requires that indirect impacts must be analyzed. The EIS must identify all the indirect effects that are known, and make a good faith effort to explain the effects that are not known but are	Since the vast majority of U.S. uranium demands are currently met by uranium imports, and the economically recoverable resource within the proposed withdrawal areas would comprise a very small portion of overall world supplies of uranium as discussed in Section 4.17, there is no evidence to suggest that the proposed withdrawal would have an effect on the mix of future U.S. electricity generation sources.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			"reasonably foreseeable." This good faith effort is missing, even though the effects actually are known and easily analyzed. This DEIS fails to do so! NEPA requirements are not being met.	
The NAU Project, LLC	242913	35	Section 3.16 AND Section 4.16 Energy Resources Available This section regarding the "energy resources available" was poorly conceived and executed and in my opinion, was written with the intent to minimized the value of the uranium in the withdrawal area The exploration and mining of uranium in the proposed withdrawal area has the greatest economic impact outside the withdrawal area, i.e., nationally. The economic impact for uranium energy resources available is much larger and more complex than is presented in this DEIS, but not so much that it is hard to conceive or understand. The introduction to Chapter 3 states:*The effected environment description will vary by resource and is not confined to the proposed withdrawal area for all resources or issues*. This caveat was applied to many resources and issues, but was plainly not applied to the concept of uranium energy resource. Uranium is an energy mineral and its primary value is not in its value as a commodity, but in the energy content that it represents. Any analysis that does not address this concept is slipshod. The Introductions goes on to say: *The information presented in Chapter 3 does not describe impacts, but rather describes the existing environment with an emphasis on the present value of these resource condition indicators.* The condition indicators for "energy resources available" and their attendant indicators are for the most part not addressed and are ignored.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS.
The NAU Project, LLC	242913	36	Starting with the description of relevant issues, the withdrawal of uranium deposits in the study area would remove a potential source of energy production. Note that the concept here is the loss of energy represented by the uranium and not the value of it as a commodity. Further, that this loss would then have to be made up by other production elsewhere, or by imports, or by production from equivalent amounts of other energy sources available, i.e., coal, petroleum, natural gas, etc. Since nuclear energy is a base load electrical power producer, coal would be the natural replacement since coal is our nations largest supplier of base load electrical capacity. Imported uranium would be the other likely replacement source. Another implied issue is, that when you replace the uranium energy resource that is removed by the withdrawal, you not only have to consider what the replacement energy resource is, but also the associated environmental impact that the production of that replacement resource has. We, as a Nation, are now exporting the environmental impact that would occur in the withdrawal area to some other location in the USA, or to some other location and peoples in the world. i.e., Canada, Uzbekistan, Africa, Australia, etc. The two concepts are not separate. Therefore another "Indicator" needs to be added and that would be: The environmental impact caused by the equivalent replacement energy	The economic analysis contained in Section 4.17 of the EIS reflects the projected market value of uranium. The value-added between the beneficiation of uranium at the mill and the actual production and sale of nuclear-generated electricity occurs primarily at the power plants themselves and through the distribution and sale of the electricity. This value-added is a return to electricity generation and distribution operations that are far from the study area, and would remain the same whether those plants use fuel originally mined within the proposed withdrawal area or fuel obtained from elsewhere in the U.S. or overseas. The analysis of specific alternative energy sources was an issue eliminated from further analysis, as described in Section 1.5.3.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			source either in the USA or a foreign country.	
The NAU Project, LLC	242913	37	"Providing a domestic source of mineral resources is one of the legitimate uses of public lands. Restrictions or closures individually and cumulatively decrease this ability." There are two aspects of the treatment of this issue within this DEIS that I find extremely troubling. One aspect is that the energy value of the uranium is declared to not contribute to energy independence, from Chapter 3.16.1: Like oil and lumber, uranium mined in the U.S. can be sold to consumers domestically or abroad, based on demand and subsequent market prices. Currently, there are no laws in place that would require domestic uranium to be solely purchased and consumed within the United States. As a result, uranium mined and produced in the United States would not necessarily move the United States toward energy independence. It is my opinion that this declarative statement is used by, and allows, the authors of this DEIS to believe that no consideration of the value of the energy resource represented by the uranium in the withdrawal area is necessary or required. The authors continue and reiterate this concept in Chapter 4 by declaring: As previously mentioned in Section 3.16.1, Energy Resources, uranium is considered a fungible commodity where it can be mined in the U.S. and sold to consumers both domestically and abroad based on demand and subsequent market prices. Currently, there are no laws in place that would require domestic uranium to be solely purchased and consumed within the United States. As a result, uranium mined and produced within the parcels would not necessarily move the United States toward energy independence and thus would not represent an impact to national energy resources. However, These statements are completely and utterly false and represent either complete ignorance or purposeful deceit. It allows for dismissing the rather large value of the energy that the uranium in the withdrawal area represents (and cumulative affects of previous withdrawals) and to the impacts discussed above that replacement energy sources are likely to have. This is a pretty neat trick if you can get away with it, but as I said before it is quite dishonest intellectually at a minimum and at most shows that there is a purposeful agenda at work.	The economic analysis contained in Section 4.17 of the EIS reflects the projected market value of uranium. The value-added between the beneficiation of uranium at the mill and the actual production and sale of nuclear-generated electricity occurs primarily at the power plants themselves and through the distribution and sale of the electricity. This value-added is a return to electricity generation and distribution operations that are far from the study area, and would remain the same whether those plants use fuel originally mined within the proposed withdrawal area or fuel obtained from elsewhere in the U.S. or overseas. The analysis of specific alternative energy sources was an issue eliminated from further analysis, as described in Section 1.5.3.
The NAU Project, LLC	242913	38	A simple mental exercise will demonstrate that the two propositions in the DEIS are false. *** See submittal #242913 for detailed info and explaination**	The economic analysis contained in Section 4.17 of the EIS reflects the projected market value of uranium. The value-added between the beneficiation of uranium at the mill and the actual production and sale of nuclear-generated electricity occurs primarily at the power plants themselves and through the distribution and sale of the electricity. This value-added is a return to electricity generation and distribution operations that are far from the study area, and would remain the same whether those plants use fuel originally mined within the proposed withdrawal area or fuel obtained

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				from elsewhere in the U.S. or overseas. The analysis of specific alternative energy sources was an issue eliminated from further analysis, as described in Section 1.5.3.
The NAU Project, LLC	242913	39	Uranium Energy Resource Value I will provide a simplified (not complete) value model for domestically produce uranium fuel mineral based on three basic values. The total value and economic impact of this model should be increase by any economic multipliers that apply for each value. A full analysis of this model is beyond the scope of what I can provide, but more qualified professionals should have no problem doing so. These values are: 1. The value of the uranium as a commodity. 2. The value added to the uranium due to processing the uranium into fuel. 3. The average electrical value of the uranium when it is sold to residential and commercial customers. ***see submittal #242913 for detailed explaination and info** The above basic analysis provides a present value for the energy resources for the lands in question and provides some prospective on the present value for the uranium fuel mineral as compared to another equivalent energy source. Similar analysis can be made for wind, solar, and gas fired power plants. The above kinds analysis and comments need to be incorporated and addressed so that this EIS can meet the requirements of NEPA and to fix major deficiencies in this DEIS	The economic analysis contained in Section 4.17 of the EIS reflects the projected market value of uranium. The value-added between the beneficiation of uranium at the mill and the actual production and sale of nuclear-generated electricity occurs primarily at the power plants themselves and through the distribution and sale of the electricity. This value-added is a return to electricity generation and distribution operations that are far from the study area, and would remain the same whether those plants use fuel originally mined within the proposed withdrawal area or fuel obtained from elsewhere in the U.S. or overseas. The analysis of specific alternative energy sources was an issue eliminated from further analysis, as described in Section 1.5.3.
The NAU Project, LLC	242913	41	Page 3-279 Energy Resources Indicators used to determine conditions regarding the availability of energy resources include the amount of undiscovered uranium resources or uranium reserves remaining at existing mines and the energy equivalent of those uranium resources. The energy equivalent is not the only measure. The "energy value" as stated in Table 3.16-22 is also considered. Left out (and should be added) of the above statement is the: Equivalent amount of other energy-producing commodity represented by uranium.	The economic analysis contained in Section 4.17 of the EIS reflects the projected market value of uranium. The value-added between the beneficiation of uranium at the mill and the actual production and sale of nuclear-generated electricity occurs primarily at the power plants themselves and through the distribution and sale of the electricity. This value-added is a return to electricity generation and distribution operations that are far from the study area, and would remain the same whether those plants use fuel originally mined within the proposed withdrawal area or fuel obtained from elsewhere in the U.S. or overseas. The analysis of specific alternative energy sources was an issue eliminated from further analysis, as described in Section 1.5.3.
The NAU Project, LLC	242913	72	Section 4.16.1 Page 4-246 Assumption List: Present and future demand for uranium will not change from 2008 demand. Simply not true, the global demand for uranium will continue to increase. Growth in tourism-related sectors will be consistent with historic growth trends in Arizona and Utah. OK, so it is alright to assume tourism-related sectors will experience growth but the demand for uranium will not. Hmmmm. What if the price of gasoline goes to 5 or 6 dollars per gallon? Might that cut into tourism growth?	The assumption was incorrectly stated in the DEIS and has been corrected in the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
The NAU Project, LLC	242913	73	Page 4-252 Energy Resources This section is just B.S. and should be deleted in whole and re-analyzed per my comments for Section 3.16. The greatest contribution of uranium exploration and mining in the withdrawal areas is reduced to a negative sound-bite based on a faulty and deceptive proposition designed to eliminate thoughtful analysis of the economic value and contribution that uranium has as a fuel mineral. NEPA requires the analysis anyway and saying that uranium does not contribute to National Energy Resources does not allow not doing the analysis. You may comment after the fact that you believe that it doesn't contribute, but NEPA does not allow such obvious and substantial indirect impacts to be dismissed un-analyzed. The lack of analysis for these issues greatly contributes to the BIAS in the writing of this DEIS, especially when the lack of analysis appears to be intentional. Each alternative should be analyzed with regards to the newly determined economic value for the uranium energy resource. See comments on section 3.16 for Chapter 3. The DEIS specifically lists the issues that were not to receive detailed analysis, but many additional issues specified to receive analysis did not receive any analysis at all, much less a detailed one. This failing must be corrected. The DEIS should be reviewed for any missing analyses and those analyses should be performed. NEPA requires the analysis be done and included in this EIS.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS. The role of nuclear energy in the nation's energy future is an issue that was eliminated from detailed analysis, as described in Section 1.5.3.
Arizona State Land Department	225280	8	At the bottom of page 2-8, in Subsection 2.4.1, the DEIS discusses previous withdrawals of federal lands in the area. These include 459 square miles for the Vermilion Cliffs and 1,638 square miles for the Grand Canyon - Parashant National Monuments. State Trust lands have also been included within and impacted by these previous withdrawals, including all or parts of 27 sections in the Vermilion Cliffs and of 51 sections in the Grand Canyon - Parashant National Monuments. All of these 78 sections of State Trust lands have been effectively closed to mineral exploration and development. While these State Trust lands are technically NOT a part of the National Monuments and are considered open by the ASLD, mineral and mining interests have told the ASLD they would not even consider trying to prospect or mine on State Trust or other open lands within the boundaries of a National Monument. This, too, suggests a loss of potential revenue for the State Trust lands and their beneficiaries.	National Monuments, Wilderness Areas, and National Parks have very different land use allocations from the "open" public lands that are the subject of the proposed withdrawal alternatives. The proposed withdrawals considered in this EIS would only withdraw Federally managed lands from mineral entry and would not impose the additional restrictions that affect National Monuments, Wilderness Areas or National Parks.
Joseph Turner	246049	12	Though it is portrayed as a source that can be used to wean society off carbon based fuel, there is no support for uranium and nuclear power replacing any carbon based plants. Scaling up production will most likely only be in addition to existing regimes of energy production, and since there is no immediate need to decrease the price of uranium, because that is probably the most insignificant of nuclear power production capital investments, the only thing driving the mining of this low grade to extremely low grade ore (as included in endowment estimates) is profit for	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS. The role of nuclear energy in the nation's energy future is an issue that was previously eliminated from detailed analysis, as described in Section 1.5.3.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			entities that offer a large amount of risk for little benefit. Please do not just state a value of 2.91 billion dollars, please also provide a pie diagram of where the money is distributed.	
Coconino County Board of Supervisors	225238	3	The economic conditions and economic impact sections of the EIS seem to have the most serious flaws. The potential positive impacts of mining are overstated and the economic impacts related to tourism are understated. The relevant sections of the EIS are 3.16 and 4.16. First of all it is important to note that mining accounts for only 0.3% of jobs in the County (Table 3.16-1), and most of those are related to cinder pits and sandstone quarries, not what is typically thought of as hard rock mining with high paying jobs having a significant impact on the economy. The jobs are important to those who hold them, but the overall impact of mining as an employment sector in Coconino County is exceedingly small and would continue to be under any of the alternatives.	The discussion of the respective roles of mining and tourism in the Coconino County economy has been revised. Please see Section 3.17 of the FEIS.
Coconino County Board of Supervisors	225238	4	The discussion of the positive impacts related to mining employment starts on page 4-247. The initial text contains the number of jobs for each phase of mining, including planning, permitting, actual mining, and reclamation. The maximum number of jobs at anyone time is stated to be 35, which in itself seems to be high based on a tour of the active mine in the North area (and is only supported by a cited personal communication from a single mining company representative), but the number of jobs is totaled over the 7-year life of a mine, yielding 75 employees. Multiplying by all 30 possible mines under the Reasonable Foreseeable Development for Alternative A yields 2,250 jobs (page 4-248). However, there are never more than 35 at one time for any given mine. Most employees have been counted numerous times to get to a total of 75. Furthermore, multiplying by the potential number of mines is exceedingly misleading as the method of operation is for only a small number of mines to be operating at anyone time, perhaps two or three, with employees and equipment moving from one site to the next as one breccia pipe is exhausted and the next is ready to be opened.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Coconino County Board of Supervisors	225238	5	The number of indirect jobs, if one agrees that the correct multiplier is nearly 2.0, which in this case is based on an economic model and not regional reality, is the total over the 20 years and not the number at anyone time. Again, most jobs are counted multiple times. If one assumes that three mines were operating at any given time, this would mean direct employment of no more than 105 and indirect employment of 210, not the 4,398 indirect jobs cited in the DEIS.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Coconino County Board of Supervisors	225238	6	While the potential positive economic impact of mining is overstated, the economic Impact of tourism in the region is understated. On page 3-254 there is an explanation of the use of the IMPLAN model to estimate the economic impacts of tourism. According to the model, 25% of the five-county region's employment is attributable to tourism-related sectors.	Discussions of the contribution of tourism to the economies in the study area in Section 3.17 of the FEIS have been revised and no longer rely on national tourism impact ratios.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			There is no question that 100% of the money spent at hotels, restaurants, bars, outdoor equipment stores, general merchandise stores, etc. is not entirely related to tourism. local residents also patronize restaurants and other businesses. So the percentage of spending at such establishments that is basic, in other words generated from outside the region, is difficult to assess without collecting primary data from each establishment. Therefore secondary data and models are used to make the estimates. However, the DE IS preparers used the national averages estimated by IMPLAN to arrive at the conclusion that only 20% of the total employment in tourism-related sectors is attributable to tourism. This implies that spending in New York City and los Angeles is a good model for spending in the Grand Canyon region, which is preposterous. In Coconino County, the spending at tourist-related businesses at the South Rim and nearby gateway communities that is attributable to locals is probably on the order of 1% or less, not 80% as the DEIS assumes. The importance of tourism and the basic sector employment related to tourism to Coconino County is critical to the County's well-being.	
Coconino County Board of Supervisors	225238	7	There is a sentence near the bottom of page 3-254 that states that employment related to mining is 4.4% lower than that provided by tourism, which must be a mistake after text above asserts that employment in tourism related sectors is 25% in the region and mining is 0.4%. The IMPLAN-derived employment for mining is 901 and the IMPLAN-derived employment for tourism is 53,222, so mining employment is 98% less than that provided by tourism, not 4.4%.	The discussion of the existing economic contribution from tourism and mining has been revised in Section 3.17 of the FEIS.
Coconino County Board of Supervisors	225238	8	It should be noted that the potential economic impact of mining is derived from the indirect impact of salaries, spending, taxing, etc. related to the employees. There is no direct revenue from the mining companies through leases, royalties, property taxes or other taxes and revenues to local governments. This is unlike the economic impact of businesses related to the tourism sector that have a substantial positive economic impact on local governments through property taxes and sales taxes.	The fiscal impact discussion in Section 4.16 of the DEIS has been revised to provide more detail in Section 4.17 of the FEIS.
Coconino County Board of Supervisors	225238	9	It is also important to note that according to the DEIS, and based on the possible exercise of valid existing claims, one third of the potential positive economic impact related to mining would still occur under Alternative B, full withdrawal. On page 4-255 there is a statement that there is 63% less economic impact under Alternative B than under Alternative A, the no action alternative. Furthermore, a reading of Section B.5 in the appendices would lead one to conclude that there was considerable guesswork involved in arriving at the likely number of future mines, albeit educated guesswork, adding to the speculative nature of estimating future economic impacts.	The rate of uranium development and number of future mines under any of the alternatives has been projected based on the best available information, but is subject to considerable uncertainty. Section 4.17 of the FEIS discusses one aspect of this uncertainty, particularly related to variability in the future price of uranium.
Coconino County Board of	225238	19	There is a brief section on public safety and potential impacts on page 4-238. Some of the statistics cited are based on personal communications	The Transportation Conflicts discussion in Section 3.16 and 4.16 of the FEIS has been updated based on new

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Supervisors			with one mining company representative and do not reflect national statistics on the probability of accidents for certain types of travel and certain types of roadways. While the number of vehicle accidents for any mode of travel is very very small relative to the total number of trips or the total number of miles traveled, it is indisputable that accidents happen. For example, accidents involving tour buses are infrequent but when they occur, they often make national news. The number of accidents compared to the total number of tours is almost infinitesimally small, yet the impact of each accident can be very large, with the potential for multiple deaths. The DE IS states that for the 10-year period from 1980 to 1990 there were only five spills, though no other details are provided on the types of accidents that resulted in the spills, whether other vehicles were involved, whether there were injuries, etc. The use of a large number of haul trucks over roads that can be heavily traveled by both locals and tourists certainly causes risks of future multi-vehicle accidents.	information provided by the public and using a more refined methodology. Further discussion of the potential frequency of haul-related accidents and spills is provided in the FEIS in Section 4.16.3.
Coconino County Board of Supervisors	225238	20	Spills are an entirely different matter whether or not other vehicles are involved. If a haul truck overturns with a load of ore, remediation must be done, including not only the material spilled, but a large amount of soil around the spill. The remediation crew is not located locally but at the mill in Blanding, necessitating long travel times to reach the scene of the needed remediation. If that spill occurred along Highway 64 between Valle and Tusayan from a haul truck that originated at a mine in the South Area, this could have very major economic implications. Numbers in the DEIS can be used to illustrate this point. According to Table 3.16-17 on page 3-272, the annual economic impact of Highway 64 is $438,960,909. If one makes the somewhat simplistic assumption that the economic value of that highway is evenly distributed on each day of the year, there is an economic impact of over $1.2 million per day. If clean-up and remediation took a week, the negative economic impact related to the spill would be $8.4 million.	The Transportation Conflicts discussion in Section 3.16 and 4.16 of the FEIS has been updated based on new information provided by the public and using a more refined methodology. Further discussion of the potential frequency of haul-related accidents and spills is provided in the FEIS in Section 4.16.3.
Washington County Commission	225251	8	The DEIS has not demonstrated that mining would result in one lost dollar in revenue to tourism business and no harm to the Grand Canyon. Contrast that with the acknowledged $3.4 billion in uranium and hundreds of jobs to be had - as well as needed energy for our country. Although the DEIS has failed to demonstrate how mining has had an adverse impact on the Grand Canyon's tourism trade, there is absolutely no question what the impact of the proposed withdrawal would be on mining related jobs and industry if it is enacted. Uranium miners earn on average $60,000 to $70,000 dollars per year plus benefits. The average tourism-related job in Arizona pays a paltry $21,000 per year while the national poverty level for a family of four is $22,300 per year.	The discussion of the economic effects of mining under the alternatives has been revised to clarify the results and reflect a revised economic impact analysis. Please see Section 4.17 of the FEIS.
Washington County Commission	225251	9	It's been stated that domestic uranium production supplies a mere eight percent of the uranium utilized by our nation's nuclear reactors, which in turn supply 20 percent of the United States' electricity. The remaining 92%	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			is supplied by other nations such as Australia, Canada, or Russia.	supplies is provided in Section 4.17 of the FEIS.
Washington County Commission	225251	10	The USGS estimates that northern Arizona contains at least 375 million pounds of the highest grade uranium ore in the United States. This is the equivalent of 27 billion kilowatt hours of electricity. This is the equivalent of all the electricity generated by all of the coal plants in the United States for 10 years. It has been estimated to be the equivalent of 13.3 billion barrels of oil, which is the total amount of recoverable oil in Prudhoe Bay. The conclusion for us is straight forward and simple.	The economically viable uranium resource under the lands considered in this EIS is estimated at 39,666 tons (about 79.3 million pounds) per Appendix B.
San Juan County Commission	243250	2	The DEIS has not completely identified, evaluated and considered the impact of the historical mining activities that have and will continue to occur in this County. Uranium mining has been an active part of the County's tax base since the 1950's. During some periods of time, there were at least three active uranium mills operating in the County. The mining portion ofthe uranium industry has been operating on and off during the last 60 plus years. Generation after generation has engaged in the mining process and this industry has provided for some the highest paying jobs in the area. One particular company, Young's Machine Company located in Monticello still produces underground mining equipment such as the Young Buggy which has been sold worldwide. The industry has provided the County, the School District, and other taxing entities with large amounts of property and other taxes. Many roads were improved during this period of time to provide access to the mines and to the mills. These roads have remained and are used by a variety of users including hunters, grazers, recreation users, and others. Many important public facilities were constructed during these times including a hospital, nursing home, medical clinics, and libraries to name a few.	The DEIS provided information on historical mining activity in Appendix B. Additional information on the historic contribution of mining to the economy in the study area is included in Section 3.17 of the FEIS.
San Juan County Commission	243250	3	The County's Master Plan specifically demonstrates the need and support for hard rock mining and its importance in the local economy. We would specifically request that the language in the County's Master Plan be analyzed and reflected in the final EIS. The State of Utah understands the importance of the nuclear industry in its new Energy Plan, specifically detailing information on how the uranium industry has and will play an important role in providing cost effective energy for generations to come. San Juan County has the only licensed and operating uranium mill.	Section 3.15 of the DEIS and Section 3.16 of the FEIS discusses stakeholder values and support for uranium mining.
San Juan County Commission	243250	4	The U.S. Uranium industry is only currently providing about 8% ofthe current national need. The demand will grow and it makes sense to use the high grade uranium that is currently being mined on the Arizona Strip to continue and to make the Nation self supporting in its portion of energy needs. There is no reason to rely on foreign sources when this energy source can be totally developed internally: President Obama has indicated in past speeches the need for a portion of the overall energy needs of the Nation to be provided in this area.	A revised discussion of uranium supply and demand and the potential contribution of uranium resources within the Proposed Withdrawal Area to U.S. uranium supplies is provided in Section 4.17 of the FEIS. The role of nuclear energy in the nation's energy future is an issue that was eliminated from detailed analysis, as described in Section 1.5.3.
San Juan County	243250	5	The impacts of mining on the local economy was not generally studied for	San Juan County was included in the analysis

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Commission			this County. The DEIS used employers from the Wasatch Front of the State that has no relationship to the local economy. Unemployment is high in the County. The study by the American Clean Energy Resource Trust (ACERT) titled "Economic Impact of Uranium Mining on Coconino and Mohave County Arizona" was completed to measure the impacts of withdrawing over 1,000,000 acres of public lands in northern Arizona from uranium mining and exploration. The study showed that if the proposal withdrawal is not implemented and the industry were allowed to operate as it did in the 1980's and 1990's, the following is a conservative estimate that would be realized in northern Arizona and southern Utah over a forty-two year period: 1,078 new jobs in the project area, $2 billion in federal and state corporate income taxes, $9.5 million in claims payments and fees to local governments, Increased property taxes for local governments, Increased business for regional and national mining support vendors, Increased state and local sales taxes, $168 million in state severance taxes, $1.6 billion to trucking firms transporting ore.	provided in Section 4.16 of the DEIS. The FEIS provides a revised and more detailed economic analysis in Section 4.17.
Hualapai Tribe-Office of the Chairman	225270	26	Socioeconomic Issues Related to Water. To sustain itself, Hualapai operates a robust tourism business that depends on the natural resources of the Grand Canyon, including water resources. Corruption of these resources, whether real or perceived, will negatively impact the Hualapai tourism industry as many patrons are environmentally conscious. A large segment of patrons would be dissuaded to use our water recreation activities due to upstream uranium mining and the threat of contamination of the water flowing through the Canyon.	The degree to which tourist behaviors are affected by perceived impacts has not been studied. Any attempt to characterize these behaviors would be speculative.
Navajo Nation Department of Justice	225264	2	The Navajo Nation would like to also state its Fundamental Position remains that there will be no uranium mining or processing within the Navajo Nation, until our expressed concerns have been adequately addressed. The Navajo Nation concerns regarding Uranium Mining and Processing have been codified in the Dine' Natural Resources Protection Act of 20 OS, CAP-18-05; and have been provided in testimony to the U.S. House of Representatives, Committee on Oversight and Government Reform, Hearing on the Legacy of Uranium Mining Impacts on the Navajo Nation," October 2007.	The DEIS includes a discussion of stakeholder values, including the position of the Navajo Nation (see Section 3.15). Additionally, the 1997 Hearing testimony is cited in this text.
Garfield County	246167	1	The document seems to be based on arbitrary and capricious information. Authors arbitrarily identified a 50 mile radius as an area of concern. Then, they promptly violated their own rule and evaluated San Juan County and the associated mill at Blanding. It should be noted that Uranium One holds a significant number of leases in the study area and also owns a processing mill. Uranium One has gone on record as by stating they intend to use the Ticaboo mill to process any uranium extracted from the Arizona strip. The validity of using a competitor's mill that is located farther away causes us to question the validity of the entire economic analysis. Did the authors understand the relationship of the milling operations with Uranium One's holdings? Did the research intentionally omit the Ticaboo milling	The study area has been revised in the FEIS to include communities more likely to be affected by the proposed alternatives than others. It is assumed in this EIS that uranium ore in the region will continue to be processed at the White Mesa Mill in Blanding, Utah, because the quantity of uranium ore determined in the Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios (see Appendix B) can be met by current milling capacity. Alternate mill locations besides the White Mesa Mill in Blanding was an issue eliminated from detailed analysis, as

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			process? Is their documented evidence that this report is well reasoned and founded on valid information given the obvious oversight by omitting the Ticaboo mill?	described in Section 1.5.3.
Garfield County	246167	2	ACERT recently completed an economic study. The socioeconomic study performed by SWCA environmental consultants makes no mention or reference to the research study. It is believed the ACERT research study has the highest most reliable quality data available for economic information. Failure to include it in the SWCA study is a fatal flaw. Based on provisions of the Data Quality Act, we respectfully request information regarding the accuracy, quality, and reliability of data used to complete the SWCA document.	The American Clean Energies Trust (ACERT) 2009 report was used throughout the DEIS (see page 6-8 of the DEIS for the full citation); please note that it is referenced in the FEIS as Tetra Tech (2009). Additionally, BLM contracted with an economist to assist in analyzing and responding to comments on the DEIS and refining the analysis for the FEIS (see Section 5.6, List of Preparers).
Garfield County	246167	3	The socioeconomic study prepared by SWCA environmental consultants is replete with general and irrelevant information, but the study lacks detailed data and analysis regarding impacts to economies custom, culture, and socioeconomics of affected areas. It seems to fulfill the requirements of documents NEPA, CEQ regulations and FLPMA condemn. Consequently economic analysis in the body of the EIS is similarly flawed.	BLM contracted with an economist to assist in analyzing and responding to comments on the DEIS and refining the analysis for the FEIS (see Section 5.6, List of Preparers). Additionally, the analysis in the FEIS has been enhanced based on input from affected counties and other sources.
Garfield County	246167	4	The draft EIS fails to mention the ACERT report. Did research use the report, and if so, why was it omitted from references cited? In as much as the ACERT report is specifically tied to uranium development in the Arizona strip, why does it not have a more prominent role in the environmental analysis?	The American Clean Energies Trust (ACERT) 2009 report was used throughout the DEIS (see page 6-8 of the DEIS for the full citation; please note that it is referenced in the FEIS as Tetra Tech (2009).
Fish and Wildlife				
Donna Brown	225253	7	Small thirsty animals, birds, and bats may be able to access them to drink, and thereby suffer acute or chronic adverse effects. While these ponds may be fenced to keep out larger animals like deer or pronghorn, could birds, bats, small rodents, and amphibians like toads and Tiger salamanders access them?	The effects of ponds are discussed in Section 4.7.4. The FEIS has been revised to include additional detail regarding potential impacts of ponds to wildlife species.
Donald Begalke	225254	11	Discussion of other affected lives would include amphibians, fish, mammals, bats, rodents, lizards, snakes and turtles. Whether a special specie or not, there are no reports in this Draft on the changes in populations over two years or five years or ... caused by negative impacts of uranium exploration efforts and at/around uranium mining operations. Affected amphibians, affected fish, affected mammals and affected turtles in the three Parcels of this withdrawal project are not specifically assessed in this Draft. Have their populations increased with uranium-mining operations, decreased because of mineral-exploratory efforts, remained constant in some areas and not in others, and how healthy are individuals of the respective populations mentioned in this paragraph? How can we have a complete environmental-impact statement without the studied reports on amphibians, fish, mammals and turtles? Respectively, BLM is	Specific locations, size, and proposed operations for potential individual mining operations are not known. Without that level of specificity, making determinations on changes in populations over two to five year periods would be speculative. This analysis describes the overall general impacts on key taxa that are representative of the potentially impacted habitat types in the project area. These species are discussed in Sections 3.6 to 3.8, and potential impacts to them are described in Sections 4.6 to 4.8 of the FEIS. Site-specific impact analysis for all pertinent species associated with any individual mining permit application will be conducted and disclosed as part of

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			requested to include such reports in the Final EIS.	the NEPA process that would be required prior to approval of the of that application and the associated mining plan of operations.
American Clean Energy Resources Trust (ACERT)	225256	38	CHIRICAHUA LEOPARD FROG, NORTHERN MEXICO GARTERSNAKE Page 3-154 Comment: The key portion of this statement is that "this species does not occur within the proposed withdrawal area." Why then would you add to the length of an already supersized DEIS with unrelated information? The above are two more examples of unrelated information. It would take too much time and space to respond to all the extraneous information you have included in these sections. Those "special" so-called environmental groups know the reason for the long list. The uranium industry knows the reason for that list as well. For the uninitiated concerned citizen who would read this document, the volume of nonsensical information stuffed into this section makes no sense at all and illustrates to the reader the vast amount of wasted time to include and the vast amount of money used to publish unneeded information.	The list the comment refers to includes those species known to occur within the counties affected by the proposed action and alternatives. This list was provided by the U.S. Fish and Wildlife Service as a starting point for the BLM to consider as they determine what species could be potentially impacted by the proposed project. This list was provided in the DEIS to enable the reader to understand what species were and were not analyzed in detail in the DEIS, and the rationale for that decision. As required by NEPA and the Endangered Species Act, the DEIS provides detailed descriptions and impacts analysis only for those species that could be potentially impacted by the proposed project alternatives.
American Clean Energy Resources Trust (ACERT)	225256	92	Pages 4-126 to 4-128 Comment: It is noted that BLM rules for permitting uranium mining specify that *No net loss will occur in the quality and quantity of suitable habitat for endemic fish, amphibians, and aquatic invertebrate species.* The requirements of the Forest Service are similar, and the Kaibab LRMP/ROD "evaluates assessment areas during mining project design and plan." "Typical compliance procedures include equipment and waste fluids are confined at all times and are disposed of at approved off-site disposal facilities." "Radioactive drill cuttings are encapsulated in sealable metal containers." Under Alterative A the reduction of in flow is approximately 1% to 2% over the 20-year period. Thus it is noted that "the impacts would not likely alter the overall fish and wildlife distribution in the study area or result in changes to overall fish and wildlife population viability." 1. It is clear from the above that this factor does not present an adequate reason to withdraw 1 + million acres of land from mining as suggested in Alterative B, or even the lesser amounts presented in options C and D. 2. It is not sufficiently made clear that even though some ephemeral springs and streams may be affected by the mining, depending on location, the detrimental effects of long droughts, drilling of water wells for local consumption, and other non-mining related activities would be considerably greater.	Cumulative impacts of past, present, and reasonably-foreseeable future actions on ephemeral drainages, and springs and seeps can be found in Section 4.7.3. The FEIS has been revised to include additional detail ephemeral drainages, and springs and seeps can be found in Section 4.7.3.
American Clean Energy Resources Trust (ACERT)	225256	93	Pages 4-129 to 4-136 Comment: It is concluded that even for Alterative A the amount of land that might impact wildlife is only 1.5% of that slated for withdrawal. So the resulting "impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability." 1. It is clear from the above that this factor does not present an adequate reason to withdraw 1 + million acres of land from mining as suggested in Alterative B, or even the lesser amounts presented in options C and D. 2.	Cumulative impacts of past, present, and reasonably-foreseeable future actions on wildlife can be found in Section 4.7.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Some discussion about the relative impacts from trails, recreational roads with vehicular traffic, campgrounds, and persons with weapons (bullet holes in the signs are evidence) should be presented. This would put the impacts from mining in perspective.	
American Clean Energy Resources Trust (ACERT)	225256	94	Pages 4-136 to 4-138 Comment: It is concluded that even for Alternative A the amount of land that might impact wildlife is only 1.5% of that slated for withdrawal. Discussions of soil contamination, vegetation resources, fish and aquatic resources, and general wildlife species a" indicate that there would not be significant detrimental effects because of uranium mining. Therefore, it may be concluded that the impact on migratory birds will also be minor. As reported "the types of impacts would be similar. 1. It is clear from the above that this factor does not present an adequate reason to withdraw 1 + million acres of land from mining as suggested in Alternative B, or even the lesser amounts presented in options C and D. 2. Some discussion about the relative impacts from trails, recreational roads with vehicular traffic, campgrounds, and persons with weapons (bullet holes in the signs are evidence) is merited. This would put the impacts from mining in perspective.	Cumulative impacts of past, present, and reasonably foreseeable future actions on ephemeral drainages, and springs and seeps can be found in Section 4.7.3.
Energy Fuels Resources	225260	10	I disagree that a major long-term impact could occur to aquatic and terrestrial habitats under Alternative A. I could not find any mention of a "major long-term impact" in Sections 4.6 and 4.7, which provide the detailed analyses for vegetation and fish and wildlife.	The Executive Summary has been revised as necessary to ensure it is consistent with the Environmental Effects reported in Sections 4.6 and 4.7.
Uranium Watch	225262	17	Section 2.8, Comparison of Alternatives; Table 2.8-1, Summary of Potential Environmental Impacts by Alternative; Water Resources. Page 2-33. There is no discussion of the extent to which existing and potential uranium mines would be in areas where water would enter the mine, requiring the mines to be dewatered during the life of the mining operation. Therefore, there is no assessment of the potential for contaminated mine water that is held in evaporation ponds or discharged offsite to impact the quality and quantity of water resources. Mine dewatering and the need to remove radium and uranium from mine water prior to discharge under a state or federal Pollutant Discharge Elimination System permit is an essential part of the operation of a uranium mine that is subject to drainage and flooding. There is no basis for the assumption that contaminated mine water would not be discharge off site. Offsite discharge has the potential to adversely impact ephemeral and permanent watercourses, riparian vegetation, and animals that drink from those water sources and consume the vegetation.	The likelihood of a mine being located in an area where water would enter the mine is low because the location mine features (such as the shaft and air vents) can be located to avoid surface features that might create such a problem. The probabilities of a mine encountering a perched aquifer influence zone are given in Table 2.8-1 under the heading Water Resources (4.4), Perched aquifer springs quantity and quality of water. The "Probability of impact" is the calculated probability of a mine being located within the estimated influence zone of a perched aquifer spring. (A detailed description of these probability calculations is given in Section 4.4.1.) Mine operations are required to acquire an aquifer protection permit from the Arizona Department of Environmental Quality. Compliance with this permit prohibits off-site discharge. Further, as described in Section 4.4.3, mines are designed with a berm around the mine site sufficient to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				withstand a 500 year flood event, and evaporation ponds are designed to withstand a 100 year flood event. The assumption that any contaminated mine materials would not be discharged off-site is based on regulatory requirements for site-specific mining operations (See Section 4.5.2 of the Draft EIS). To assume that these regulatory requirements would not be followed at the site-specific implementation level is speculative.
Uranium Watch	225262	38	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The DEIS discussion of Impacts Common to All Alternatives (Section 4.2.4, page 4-16) manages to totally ignore the radioactive and hazardous constituents of any fugitive dust from the mining operation. The EIS must identify all hazardous radioactive and non-radioactive constituents of fugitive dust from the uranium mining operations and assess their impact on the environment. This would include an evaluation of potential exposure pathways and impacts to the public, workers, ground and surface water, soils, vegetation, and native and domestic animals over the short and long term.	Potential impacts of fugitive dust and any potential radioactive constituents on vegetation, soil, and wildlife are discussed in Sections 4.6.1, 4.6.3, and 4.7.4 of the Draft EIS.
Uranium Watch	225262	75	Section 4.7 (page 4-119) states: *The impacts discussion of this DEIS assumes all mining projects within the study area would comply with standard environmental regulatory requirements and procedures*. Here the DIES assumes that the standard environmental regulatory requirements and procedures are adequate to protect the environment from adverse impacts of uranium mining. The problem is that the regulatory requirements and procedures of the BLM and USFS were not developed specifically to deal with the unique impacts of uranium mining, such as the dispersal of radionuclides into the environment or the need for long-term care of contaminated areas. Further, based on the current BLM regulation of uranium mining operations on BLM land, there is no basis for the assumption that the uranium mining operations will comply with all state and federal regulatory requirements and procedures. Denison Mines, the primary owner of existing uranium mines in the area, has already shown a lack of commitment to compliance with regulatory requirements of the ADEQ and the Mine Safety and Health Administration (MSHA). A review of the violations at the Arizona 1 Mine (Mine ID 0202443), show a continual pattern of inattention to worker health and safety requirements. Looking at the history of the operation of Denison's Pandora and Beaver Shaft Mines in La Sal (Mine ID 4200470), there is a history of increasingly serious health and safety violations and increasing amounts of penalties over the past two years. These violations include those associated with a fatal mine accident, exposure of workers to unacceptable levels of radon, and faulty equipment. I would direct the reviewer of these comments to the MSHA	The federal government is required to do NEPA on an action that is proposed, and is therefore, ripe for analysis. In this case, that action is only the proposed mineral withdrawal, not the permitting of actual mining operations. The Draft EIS analyzes the impacts of a proposed mineral withdrawal, including the reasonably foreseeable mineral development under each alternative.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			description of violations at the Pandora Mine Complex.	
Uranium Watch	225262	76	Section 4.7 does not give any indication that it considers the impacts of the emission of radon and radon progeny from the mine vents on wildlife. The EIS must evaluate those impacts.	Section 4.7 has been updated to add more depth to the discussion on emission of radon and radon progeny,
Pew Environment Group	225274	5	While we understand that the Department cannot predict precisely which springs might be at risk, we believe that the DEIS should recognize that even temporary loss of an individual spring could have serious repercussions for the Park area's species diversity. Even if spring flows are eventually restored, species loss could be permanent.	Section 4.7 has been updated to include more discussion on aquatic hazards.
Pew Environment Group	225274	10	It is clear from the recent USGS report on biological pathways that the ecological assessment of potential impacts is hampered by lack of species-specific toxicity data on uranium and an acknowledged lack of information on habitat usage within the three parcels. In addition, the analysis does not cover selenium, arsenic or other constituents that may occur with the uranium, be mobilized in the environment by mining, and, as the USGS points out, be as harmful or more so than uranium. The Department should take seriously the caution offered by these studies that uranium and other radionuclides can impact survival, growth and reproduction, and the particular concern expressed for animals that would use mine shafts for habitat or spend significant amounts of time in burrows where they can inhale or ingest contaminants. Special consideration should be given to protecting plant-eating species, such as the desert tortoise, elk and bighorn sheep, that may experience high levels of exposure from wind-deposited contamination on vegetation, birds that may be a greater risk to radiation exposure compared with other vertebrates, and fish species that may concentrate uranium.	Section 4.7 has been updated to include a more detailed discussion on other inorganic constituents and potential radiation hazards.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	25	Because the DEIS fails to analyze a worst-case groundwater pollution scenario, we are generally concerned that the DEIS also underestimates potential effects of uranium mining to species dependent on surface water in the withdrawal area and Grand Canyon National Park. As the DEIS describes, species occupying those aquatic habitats are particularly prone to harm from mining pollution or water depletion: Uranium and its decay products can be transported by way of infiltration into groundwater and surface waters. In addition to aquatic exposure pathways, wildlife can be exposed to chemical and radiation hazards through various pathways, including ingestion of soil and food (prey species), inhalation, and various cell absorption processes. As discussed by the USGS (Bills et al. 2010), some streams, seeps, and springs within the proposed withdrawal area contain high concentrations of dissolved trace elements and radionuclides owing to past mining activities and natural processes of evaporation, weathering, and erosion. Aquatic organisms and plants rely on these water bodies, and minor changes in water quality and quantity could result in mortality of fish and other aquatic organisms or in degradation of their	The potential impacts of uranium mining on wildlife are disclosed in Sections 4.6.1 and 4.7.4 of the Draft EIS. The EIS analyzes impacts that are anticipated to occur from implementation of the four alternatives.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			habitat. DEIS at 4-144. Under a worst-case pollution scenario, we would expect those effects to be greatly magnified.	
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	27	Nor does the DEIS sufficiently consider the potential impacts of uranium mines on migrating birds. BLM does not require uranium mine tailing ponds to be covered. Migrating birds, especially water birds, can therefore be attracted to mine tailing ponds for feeding, wading, drinking, bathing and resting during migration. Because mine water can be polluted with mining waste, exposure to mine tailing pond water could poison or kill migrating birds. Because mine ponds contain no fish or invertebrates, migrating water birds that are attracted to and attempt to forage in mine tailing ponds will expend energy attempting to gain energy, thereby depleting rather than restoring critical fat reserves necessary for migration. In these ways, uranium mining tailings ponds can serve as habitat traps for migrating birds. In April of 2011 Taylor McKinnon of the Center for Biological Diversity documented a White-faced ibis (Plegadis chihi) at the Pinenut mine tailing pond. It was perched on the barbed-wire fence adjacent to the pond and was observed perched at and flying over the pond. (Figure 1) **See comment #225279 for figure information**	Potential project impacts on migratory birds are disclosed in Section 4.7.5 of the Draft EIS. This section of the FEIS has been revised to provide additional detail regarding these impacts. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	28	Fig. 3.7-1 in the DEIS ignores some critical wildlife linkages, and may therefore underestimate the impacts of mining and hauling on large mammals. Maps of radio-collared deer prepared by the Arizona Game and Fish Department (AGFD), and a dispersing mountain lion tracked by the National Park Service (NPS), reveal nearly identical travel routes for these large mammals between the Grand Canyon and the San Francisco Peaks (Fig. 1, this document). Fig 3.7-1 should be amended to show this corridor, which covers a large portion of the south segregation area. Mining and trucking activities that bisect a wildlife corridor could disproportionately impact animal populations. Mule deer and elk stay at least 500-3700m from developed areas when possible, and shift distributions into more marginal habitats to avoid mines (Edge & Marcum 1985, Sawyer et al 2006). Impacts to wildlife corridors are predicted to negatively impact wildlife populations and recreation (hunting, wildlife watching, photography). **See comment #225279 for figure information**	Section 4.7.4 discloses the potential impacts of the project on general wildlife, including the quantification of potential habitat impacts associated with noise from development. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon	225279	29	There may be more unidentified migration corridors in other parts of the action area. For example, a letter from Norris L. Dodd, then-president of The Wildlife Society, to G. William Lamb, District Manager of the Bureau of Land Management (BLM) on April 3, 1988, identifies the vicinity of the Arizona 1 Mine as a travel corridor for pronghorn antelope (Dodd 1988 letter, attached). This corridor is not identified in Fig 3.7-1.	The analysis of this EIS has been prepared based on the best available information.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Chapter, Center for Biological Diversity				
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	30	The map on the right side of Fig. 1 is evidence of mountain lion presence in the proposed withdrawal area, and the column Documented in the Proposed Withdrawal Area? in Table 3.7-1 in the DEIS should be amended from Possible to Yes for mountain lions. Risks to mountain lions, as Management Indicator Species (MIS), are recognized in the DEIS (p. 3-123): Large tracts of roadless habitat are necessary to maintain individual populations, and the corridors that connect these tracts are required for dispersal of lions between populations. In addition, any loss of habitat of their prey species (deer) may cause a reduction in the mountain lion population. DEIS 3-123. Prey species such as deer will be impacted by uranium mines in and near these corridors. For example, the Final EIS for a single mine, the Canyon Mine (USDA 1986), states: "Five elk calving areas totaling approximately 2,000 acres, have the potential to be impacted by the mine proposal... Water is an important component in elk calving habitat. Calving occurs during the dry months of May and June when water becomes limited. This makes the habitat adjacent to reliable waters particularly critical. Each of the known calving areas is within the proximity of a reliable water source." (p. 3.15, USDA 1986) "Approximately 9,900 acres of deer fawning habitat have been identified in the vicinity of the mine and ore haul routes" "Quality forage and available water are essential components in optimum fawning habitat. (p. 3.18, USDA 1986) "Three [antelope] fawning areas, totaling roughly 2,300 acres have been identified in the vicinity of the mine and ore haul routes." (p. 3.18, USDA 1986) "Approximately 1,600 acres of turkey nesting habitat have the potential to be impacted by the mine." (p. 3.18, USDA 1986) Haul route traffic is likely to disrupt the use of adjacent wildlife water sources. "These waters represent 13 percent of all reliable waters in the affected area which are historically used by wildlife. The predicted loss in utilization of these tanks will reduce the overall habitat carrying capacity." (p. 4.15, USDA 1986) Impacts to deer, elk, antelope, and turkey will negatively impact wildlife populations and recreation (hunting, wildlife watching, photography). **See comment #225279 for figure information**	Table 3.7-1 of the FEIS has been revised to address these concerns. Section 4.7.4 discloses the potential impacts of the project on general wildlife, including the quantification of potential habitat impacts associated with noise from development.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	31	Roads will not only remove and fragment habitat, increase mortality from vehicle collisions, release dust, spread non-native species, create noise and visual impacts; it will also lead to the negative impacts that accompany easier access to remote areas. One of these impacts, which is not addressed in the DEIS, is poaching. A letter from Richard W. Marks, then-Superintendant of Grand Canyon National Park, to BLM, dated May 6, 1988, raises concerns about increased poaching when roads create easy access to remote areas (Marks 1988 letter, attached). More recently, in proceedings at the 2009 Arizona Hydrological Society Annual Water	To assume that poaching would occur as a result of project alternatives and to determine the level of potential impacts of that poaching is speculative and is not appropriate in a NEPA analysis. Poaching is an illegal activity that would be addressed through law enforcement.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Symposium, Don Bills of the U.S. Geological Survey (USGS) recognized that, "Increases in wildlife poaching within and near the park boundaries have been associated with increased mining exploration activities in previous years." (Bills et al. 2009) Poaching will negatively impact wildlife populations and recreation (legal hunting, wildlife watching, photography).	
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	48	Soundscapes should not only be protected for people, they should also protect wildlife. According to the Organic Act [16 USC 1], the purpose of the National Park Service includes conserving "the wild life therein". Sound studies and modeling for the DEIS are weighted to represent human hearing. The DEIS should consider that wildlife can be harmed by sound disturbances. According to a recent sound study, humans will perceive an approximately 100-fold sound increase in some areas of Grand Canyon National Park, due to mining activities, but the actual measured sound in these locations will be 2000 times ambient sound (Ambrose 2010). This, for example, could impact bats, of which there are at least 20 species in Grand Canyon National Park, 10 being species of concern to one of the wildlife governing agencies (NPS 2010, pp. 22-24). Bats rely on sound to navigate and feed. If hibernating creatures are disturbed, they could expend more energy than they have reserved for the winter season, leading to mortality.	Potential impacts to bats are disclosed in Sections 4.8.4 through 4.8.7 of the Draft EIS. Additionally, this discussion on bat impacts has been updated in the FEIS to provide additional detail on the timing of potential reasonably-foreseeable mining activities for non-withdrawal alternatives and how that relates to impacts on bats.
Doug Reagan	242175	3	More information is needed on the species distributions in the potentially affected area, their movements, seasons of activity, and use areas (e.g., nesting, feeding).	Key wildlife species that are representative of potential wildlife impacts are discussed in Sections 3.6 through 3.8 and 4.6 through 4.8 of the Draft EIS. Specific species analyses for individual mining permit applications would be disclosed as appropriate through site-specific NEPA conducted prior to approval of those mining operations. This analysis is based on the best available information.
VANE Minerals	242650	6	Under Impacts on Fish and Wildlife in the Executive Summary, page ES-14, when discussing wildlife habitat and habitat fragmentation, the DEIS states: "Alternative A would have a minor to major long-term impact on aquatic and terrestrial habitats ... ". What exactly, is the quantitative basis for this statement? Further to this, Table 4.10-7 (Page 4-198) predicts, for the South Parcel (which encompasses the entire Tusayan Ranger District), the construction of 3.6 miles of new road . The DEIS does not mention that the USFS is considering plans to close over 140 miles of existing roads while leaving over 560 miles of road open in the Tusayan Ranger District alone . Nor does the DEIS clarify that reclamation of new mine roads can be required, therefore making impacts temporary. The DEIS inference of minor or major longterm impact on habitat fragmentation from 3.6 miles of "temporary" road is unfounded.	The FEIS has been revised as necessary to ensure that the Executive Summary is consistent with the analysis described in Section 4.7.3.
Mary Crowe Costello	242652	5	How would increased truck traffic associated with these mines impact local wildlife, such as ungulates and raptors? I have property in southeastern	Section 4.7.4 of the Draft EIS discloses the impacts of roads on wildlife species, including risks of

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Utah and have witnessed the amount of wildlife killed by uranium haulers in the corridor between Blanding and Moab, Utah. It is having a big impact on local ungulate populations.	vehicle/wildlife collisions.
Arizona Elk Society	242661	1	Although the DEIS is correct in stating that several of the Federally-listed big river fish such as humpback chub and Colorado River pikeminnow are not found in the project area, we feel that the document is remiss in not adequately identifying that activities in the watershed of Kanab Creek could have dramatic impacts on these unique resources.	Sections 4.7.2, 4.7.3, and 4.7.4 of the Draft EIS disclose the potential project alternative impacts on Kanab Creek and associated wildlife.
The NAU Project, LLC	242913	66	Section 4.7 Fish and Wildlife This section should be reviewed after other sections within this DEIS have been "corrected" based on comments received. The Water Resources section deserves heavy revision and so impacts to fish and wildlife may have to be revised accordingly.	Section 4.7 of the FEIS has been revised as necessary to address substantive comments made on the DEIS.
The NAU Project, LLC	242913	90	4.7 FISH AND WILDLIFE page 4-119 As previous discussed in Chapter 2, the BLM and Forest Service require the preparation of plans of operation for all uranium mining projects. Plans of operation include standard operating and reclamation measures to minimize or mitigate impacts to fish and wildlife resources. Like what?	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Fish and Wildlife Service	242660	5	Page 1-22, Table 1.5-1: A potential impact on fish and wildlife resources and special status species also includes the possible chemical (uranium and other heavy metals) and radiation contamination of these resources through ingestion of plants, uptake of water, and exposure to soils in the vicinity of mining operations.	Section 1.5.2**,** Table 1.5-1. Fish and Wildlife Resource Section, sub columns has been revised to add additional discussions regarding potential impacts to fish from chemical and radiation contamination.
U.S. Fish and Wildlife Service	242660	37	Page 4-130, first partial paragraph: The referenced study compared small mammal populations along an interstate in Utah and a two-lane highway and an existing transmission ROW road in forested habitat in British Columbia. The results of this study have limited applicability here to the effects of new roads on larger mammals in this arid environment.	Discussion on impacts from roadway on general wildlife species is included in Section 4.7.4. Referenced reports on Wildlife and impacts of roads have discussions on many variables that apply including seasonal variables, terrain and other obstructions play a large role in conflicts and shy distances to roads. Discussion in Section 4.7.4 includes a 1/2 mile 'zone' around all roads and power lines, which is a physical acreage impact to quantify potential impacts associated with roadway noise, air quality, habitat modifications, and other visual disturbances.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
U.S. Fish and Wildlife Service	242660	38	Page 4-131, first paragraph: Biological soil crusts are also important for holding soil (especially topsoil) together and preventing erosion.	Section 4.7.4 of the FEIS has been revised to provide additional detail regarding biological soil crusts.
U.S. Fish and Wildlife Service	242660	39	Page 4-136, Migratory birds: Impacts to aquatic habitats could result in impacts to other bird species using these habitats, in addition to wading birds. Also, we could not locate the discussion about impacts to wading birds in Section 4.7.4 that is referred to here.	Section 4.7.6 of the FEIS has been revised to provide additional detail regarding impacts to wading birds.
U.S. Fish and Wildlife Service	242660	40	We recommend acknowledging the risk to migratory birds from water collection ponds within mine operation areas. Based on sampling conducted by USGS, these ponds have high levels of radiation and contamination. Measures to mitigate the risk of this exposure to migratory birds, as well as risk associated with exposure to waste rock piles and other sources of contamination, should be developed and incorporated into future plans of operations.	Impacts to migratory birds are discussed in Section 4.7.5 of the DEIS. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Fish and Wildlife Service	242660	43	We also recommend including a conservation measure to add perching and nesting deterrents to any utility structures erected in or near mine sites so that large raptors, including bald and golden eagles as well as condors, are discouraged from using these facilities.	The applicability of perching and nesting deterrents in or around potential future mine sites would be determined based on site-specific NEPA analysis that would be completed prior to approval of specific proposed mine projects. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Geological Survey	242871	1	The DEIS considers impact in terms of habitat destruction and/or fragmentation and the repelling of species from the area. We disagree because this approach fails to account for mining sites being attractive nuisances for some species. Some species will be drawn to the area (and	Section 4.7 of the FEIS has been revised as necessary to address these concerns. The purpose of the EIS is to analyze the effects of the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			thus have greater potential exposure) because of water availability in the waste ponds, human activity, and perching structures. Migratory birds are good examples of species that may be attracted to mining sites.	Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Geological Survey	242871	2	*Increased levels of uranium and decay products are anticipated to be minor and long term to biological resources.* There is no scientific basis for this statement in the DEIS nor data to support it from our USGS report. Site specific contaminant data is lacking but needed. To truly make such a statement, a risk assessment needs to be performed as suggested in our BRD chapter.	Both the Executive Summary and Section 4.7.2 of the FEIS have been revised as necessary to address these concerns.
U.S. Geological Survey	242871	3	The DEIS evaluates impact based on habitat but fails to account for chemical toxicity, and radiation toxicity is barely even mentioned in the DEIS because of its focus on aquatic habitats.	Sections 4.7.3 and 4.7.4 of the Draft EIS disclose potential chemical and radiation toxicity impacts on aquatic and terrestrial species respectively.
U.S. Geological Survey	242871	5	Habitat quality is only discussed in terms of aquatic habitat quality. We disagree with this because terrestrial habitat is sensitive and should be considered as well. A good example is Kanab North mine (below) which hasn't been mined for 20+ years. Note how vegetation has not re-established within the mining perimeter.	Section 4.7.4. of the Final EIS has been revised as necessary to provide additional detail regarding these impacts.
Arizona Game and Fish Department	242655	1	Increased uranium activity within the three parcels may result in wildlife disturbance, changes in habitat use by wildlife, and/or reduction in wildlife habitat quality. For example, Gavin and Komers (2006) found that pronghorn foraging behavior was disturbed along high traffic roads, but that general risk-avoidance behavior was higher near roads regardless of traffic level, suggesting an overall perception of risk toward road disturbances.	Section 4.7.4 of the Draft EIS discloses the impacts of roads on wildlife species, including risks of vehicle/wildlife collisions and impacts on habitat quality and quantity.
Arizona Game and Fish Department	242655	2	Changes in habitat use by wildlife, Sawyer et al. 2009 found that mule deer responded to oil and gas operations by selecting habitats 2.61 km from roads traveled by 2-5 vehicles per day, 4.3km roads traveled by 4-9 vehicles per day, and 7.49 km from roads traveled by 86-145 vehicles per day. While oil and gas exploration may not be comparable to uranium mining on some levels, vehicles per day in this research does approximate what the DEIS suggests will be the increase due to mining activity	Section 4.7.4 discusses impacts from roadway on general wildlife species. Referenced reports on Wildlife/road have discussions on many variables that apply including seasonal variables, terrain and other obstructions play a large role in conflicts. Discussion in Section 4.7.4 includes a 1/2 mile 'zone' around all roads and powerlines which is a physical acreage impact to quantify potential impacts associated with roadway noise, air quality, habitat modifications, and other visual disturbances.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Section 4.4 addresses water resources in more detail.
Arizona Game and Fish Department	242655	5	The Department also has concerns that uranium drilling may decrease perched aquifer water resources. The DEIS states that this is a possibility in Chapter 4, page 126. As you are aware, the Department is engaged in efforts to manage natural and artificial water sources for wildlife when necessary. The Department actively manages wildlife waters because research has shown that natural and artificial sources are important for multiple species. For example, Ockenfels et al. (1992) suggested the free water could make the difference between good and poor pronghorn fawn recruitment when forage moisture is low. Rosenstock et al. (2004) concluded that nongame species visitations at water sources often exceeds game species visits, and includes a high diversity of species like bats.	Sections 4.7 and 4.7.3 of the Draft EIS disclose the potential impacts of project alternatives on perched aquifer water resources and associated wildlife species.
Geology and Mineral Resources				
Five County Association of Governments	50521	1	Northern Arizona contains some of the highest grade uranium deposits in the nation. In a time when the country is in desperate need to lessen dependence on imported energy resources and nuclear power generation will be a vital part of the national long-term energy strategy, it is folly to withdraw some of the best proven uranium resources on federal lands from use.	The purpose and need for this action are described in Section 1.3.1. How a potential withdrawal would comport with national long term energy strategy may be a factor in the Secretary of Interior's Decision on Withdrawal, but is not relevant to the EIS analysis.
Robert Grossman	54251	2	The projected demand for U does not specify if it includes the amount recoverable from decommissioned weapons. Further it does not mention the U recoverable from the tonnes of greater than 0.2 tails stored by the AEC/DOE. Both should be listed to confirm the validity of the demand estimate.	It is assumed that the commenter meant the projected uranium supply, not demand. The estimate provided from EIA does not include any recoverable from decommissioned weapons or from tails. Section 3.3.2 of the FEIS has been modified to indicate this.
Lawrence M'tigue	94040	3	(Page ES-14) says: *Impacts on Geology and Mineral Resources: Alternative A would have no impact on the underground geological conditions, availability of mineral resources, or depletion of uranium resources within the proposed withdrawal area. Alternative B would reduce the number of ore deposits mined but would not change the potential for subsidence or alteration of geology or topography in the proposed withdrawal area.*.Comment: In the first sentence, at the start of the paragraph (above), it says: "Alternative A would have no impact...". This is (extremely) poorly worded. Did you mean to say Alternate B, rather than Alternate A? I understand what (might) be meant, since (in effect), no change in (current) management of those areas would occur. But, what that also means is that (new) uranium mining claims (would) continue to be (allowed) and (new) uranium mining (would) increase, with few restrictions	Wording to the Executive Summary has been modified.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			imposed. So, with all that (new) mining activity (taking place), impacts "on the underground geological conditions, availability of mineral resources, or depletion of uranium resources" would (indeed) be impacted!!! If you really (did) mean to say Alternate A, then you should re-word it to say: "Alternative A would have no impact on the (current management policies) of the land areas being discussed here. Under Alternate A, (extensive) impact on underground geological conditions and (extensive) depletion of uranium resources from (unrestricted) mining of uranium (would) occur, under Alternative A. If you meant to say Alternative B, then you need to change it, to (say) Alternative B.	
Lawrence M'tigue	94040	4	(also on Page ES-14): (under) Impacts on Geology and Mineral Resources It states: *Alternatives C and D would also reduce the number of ore deposits mined but would not reduce the number as much as Alternative A. Alternatives B, C, and D would also cause a moderate to major long-term impact to the availability of mineral resources and depletion of uranium resources within the proposed withdrawal area.*Comment: In the first sentence above, did you mean to say: Alternatives C and D would also reduce the number of ore deposits mined but would not reduce the number as much as Alternative B? Alternative A would (not) reduce the number of ore deposits (mined), at all!!! On the contrary, Alternative A (allows) nearly (unrestricted) filing of (new) uranium mine claims and virtually unrestricted (mining) of uranimum in all (3) areas!!! If this was worded incorrectly, it needs to be changed to Alternative B (not) A!!! In the last sentence, it says: *Alternatives B, C, and D would also cause a moderate to major long-term impact to the availability of mineral resources and depletion of uranium resources within the proposed withdrawal area.*.This is also (very) poorly worded. It should be changed, to state the following: Alternatives B, C, and D would also cause a moderate to (major) long-term impact, in the (availability) of mineral resources (to the mining industry). Also, (depletion) of uranium resources would occur, within the proposed withdrawal areas, where (some) current mining claims would continue to be allowed. Some (new) uranium mining claims would be allowed, under Alternatives C and D, but (not) under Alternative B.	Wording to the Executive Summary has been modified
Frank Bain	215490	3	My last comment has to do with the gross underestimation of the number of breccia pipes that are thought to exist in the proposed withdrawal area. Most of the government scientists and others involved in determining the percentage of pipes thought to exist in the withdrawal area are not seasoned explorationists and do not have the expertise or access to confidential company data to determine how many pipes are present in this area. Most exploration geologists familiar with the area agree that the 12% number given in the EIS is a gross underestimation of the number of pipes that will be made off limits by the withdrawal. Just look where the majority of the mining claims are located. This issue must be revisited, and the numbers revised with the input of industry and knowledgeable	The USGS Report is a peer-reviewed publication that provided the estimated uranium endowment for the proposed withdrawal area. While some commenters have presented alternate or supplemental approaches to assessing the uranium endowment from that provided by USGS, these alternate approaches have not been developed or peer reviewed to the extent that they can replace or supersede the USGS endowment assessment presented in SIR 2010-5025. As with many scientific fields, new information is constantly being collected which leads to new or refined

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			professionals to accurately reflect the impacts of what withdrawing this valuable resource will have on local communities and America's security.	conclusions. However, at present, the USGS Report contains the best credible information available regarding the uranium endowment estimate and was therefore used as the basis for the reasonably foreseeable development scenarios in the EIS.
DIR Exploration, Inc.	225241	1	The general and specific assessments of uranium resource potential provided at http://www.blm.gov/az/st/en/prog/mining/timeout/maps.html as Segregation Mineral Potential Report and as Chapter A, Uranium Resource Availability in Breccia Pipes in Northern Arizona, in Hydrological, Geological, and Biological Site Characterization of Breccia Pipe Uranium Deposits in Northern Arizona, do not take into account a geologically-obvious structural control of the distribution of economically-mineralized uranium-bearing breccia pipes in northern Arizona. Resource estimates qualified by recognition of this clear control of the location of economic breccia pipe uranium mineralization show that the proposed withdrawal of about 1,000,000 acres of northern Arizona will not result in a small 12% decrease of the Arizona uranium resource availability, but will instead result in a much larger (6x) 76% decrease in availability of this particular domestic energy resource. ***see comment submittal # 225241 for more detailed explanation, Including figures, rational and citations.**	See RFD Comment 225241:4
American Clean Energy Resources Trust (ACERT)	225256	24	3.3.1 GEOLOGICAL SETTING Page3-30, Paragraph 2 Statement: *The Colorado Plateau is known generally for unique geological features, including the widespread prevalence and color of exposed sedimentary units, the occurrence of isolated volcanic mountain complexes, and erosional features such as mesas, cliffs, escarpments, and incised stream canyons. While not within any of the parcels, the Grand Canyon dominates the geological setting and forms the partial geographic boundary of each parcel; the side tributary canyons to the Grand Canyon form the surface drainage network within the parcels.* Comment: The second sentence states that; "the Grand Canyon .... forms the partial geographic boundary of each parcel." This is false. The Grand Canyon only forms part of the boundary of the East parcel. The Grand Canyon as a geographic feature nowhere is part of the proposed withdrawal boundary for the North or South parcels	Text in Section 3.3.1 of the FEIS has been reworded
		25	Locatable Minerals Pages 3-32 to 3-35 Table 3.3-1, Page 3-32 Comment: The amount of U30 in the Arizona Strip area as estimated by the US Geological Survey is 163,380 tons, (326.76 million pounds) (see Table 3.3-1, page 3-35 and Appendix B, Table B-4, page B-25). Yet when making statements as regards the total amount of U30 in the country the DEIS uses the 2003 values from the EIA of 123 million pounds in Arizona, Colorado, and Utah combined (see Table 3.16-20, page 3-275). This leads to the conclusion that the amount of resource in Arizona is not Significant with regard to the entire country. This discrepancy needs correction and resolution, because it is often quoted in the media (and in economic	See RFD Comment 225256:129

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			analyses) without the background mentioned above.	
		26	Page3·35 Statement: *The original Hack Canyon mine was similarly discovered as a mineral exposure at the base of the canyon wall in Hack Canyon and was mined from the floor of the canyon; descriptions of mine techniques are provided by Chenoweth (1988). Approximately 1,400 tons of dry ore were removed from the Hack Canyon mine. Mining was conducted entirely underground through several vertical shafts, horizontal tunnels, and stops to a depth of approximately 100 feet. Mining ceased in 1964. In the 1970s and 1980s, three additional breccia pipes were discovered in the vicinity (Hack 1, Hack 2, and Hack 3 and known collectively as the Hack Canyon Complex). All three breccia pipes were mined from approximately 1981 through 1987 (USGS 2010b), resulting in the removal of approximately 742,000 tons of dry ore (Hack 1 -134,000 tons, Hack 2 - 479,000 tons, Hack 3 - 111,000 tons) (personal communication, Spiering 2010). Reclamation of all three of these pipes, as well as the historic Hack Canyon workings, was completed in 1988. No evidence of subsidence resulting from the mining has been identified.* Comment: The EIS says the original Hack Canyon Mine was mined from the floor of the canyon, and later Hack 1, Hack 2, and Hack 3 were discovered. The truth is that the Hack 1 orebody was discovered by drilling on the site of the original Hack Canyon copper mine, and the two are in the same breccia pipe. There are only 3 breccia pipes in the Hack Canyon Complex. Considerable effort was expended in searching for additional pipes in the area of the 3 mines, without success.	The history of the Hack Canyon complex offered by the commenter is at odds with that summarized by the USGS, which identified four individual breccia pipes in Hack Canyon. The USGS Report is a peer-reviewed publication and represents the best credible information available regarding uranium development in the area.
		65	Pages 4-38, and 4-40 Statement: *Under Alternative A, the mines would produce 33,155 tons of URANIUM (U30 S)" over a 20-year period. Under Alternative B, this would be reduced to 4,147 tons* Comment: This is a reduction of 29,008 tons. What is the rationale to deprive the local economy of the benefits of 87.5% of the mineral? It is recognized that these values are computed on a different basis. However, the net result shows that 11 mines would produce only 4,147 tons of U30 and the other 19 would produce 29,008 tons. By presenting the material in this manner, there is a bias towards emphasizing that the production when there is withdrawal (Alternative B) is considerably less than when mining is allowed (under Alternative A). Should an EIS present the data in such a manner and claim to be objective?	See RFD Comment 242664:13 concerning the change to these numbers.
		66	Page 4-38 Statement: *No estimates have been made of the magnitude of low-grade uranium ore that might remain in a reclaimed mine.* Comment: The EIS says that no estimates have been made of the amount of low grade ore left in a reclaimed mine. There is relatively little uranium-bearing rock in the northern Arizona breccia pipes which is below economically mineable grade. Most of the rock in the pipes either has a uranium content high enough to justify mining and shipping to the mill or it contains only geochemical background amount of uranium. This should be stated in the	Based on literature examining historic mines, low-grade ore has been left in mines in the past. This is not necessarily the case for future mines. Text has been modified in Section 4.3.4 of the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			document.	
		67	Pages 4-39 Comment: The DEIS says these alternatives would shift uranium mines from federal land to State and private land. This is not true and needs to be corrected in the DEIS. The private enterprise companies have already diligently pursued finding uranium on State land, with some limited success. There is no guarantee that the State of Arizona will allow mining of uranium on deposits discovered on state land. In the past Energy Fuels spent considerable money discovering and defining a commercial uranium deposit on leased state land. When they applied for a mining lease (WHAT DEPOSIT) they were denied, apparently because of the extreme left politics of Governor Bruce Babbitt. If the State of Arizona in the future should succumb to pressure from the Federal government and radical anti-development groups, or if a Democrat were to be elected governor, this could be repeated. There is very little State land north of the Grand Canyon, therefore few if any mines can be expected there. There is almost no private land in areas of good potential for uranium deposits north of the Grand Canyon, therefore no mines can be expected on private land there. Of the private land south of the Grand Canyon, the Boquillas Ranch belongs to the Navajos and their tribal policy is to NOTallow uranium mining on tribal lands. The Babbitt family can, likewise, be counted on to refuse to lease mineral rights for uranium exploration and mining on their land. Therefore the statement that denying uranium mining rights on BLM and Forest Service land will shift the uranium mines to State and private land is not true. The uranium companies have already put a maximum effort into finding uranium deposits on State and private ground as well as Federal land. This statement needs to be corrected in the DEIS. In addition, just because the land belongs to the state or to private individuals that does not mean that the presence of uranium exists there.	Text has been changed in Section 4.3.1 of the FEIS to further discuss this issue.
		68	Page 4-39 Statement: *Only locatable minerals are to be withdrawn according to the July 21, 2009 notice although there is "moderate potential" for oil and gas in the North Parcel "based on oil shows in several wells."* Comment: This would imply that exploration for oil and gas may continue, (with the associated roads, traffic, power lines, etc.) and its impacts on air, water, wildlife, cultural resources, and so forth would be acceptable. Why would exploring for locatable minerals become intolerable? This would appear to be a discriminatory action against uranium mining companies.	As stated in the notice of proposed withdrawal published in the Federal Register on July 21, 2009, the withdrawal is from "location and entry under the 1872 Mining Law, but not the mineral leasing, geothermal leasing, mineral materials laws, or public land laws." 74 Fed. Reg. 35887 (July 21, 2009). Consequently, the commenter is correct that exploration for oil and gas may continue under the mineral leasing laws, subject to the Secretary's discretionary authority. In addition, any withdrawal from the Mining Law would withdraw all locatable minerals, not just uranium.
Energy Fuels Resources	225260	21	Section 4.3.1, Page 4-37: The average U,S. citizen is not able to translate pounds or tons of uranium into a meaningful context. I suggest providing the power generation equivalent of the estimated production for each alternative in a readily understandable manner. For example, the number of Phoenix Metropolitan areas that could be powered by the uranium once	There is no guarantee that uranium mined from the proposed withdrawal area would be used to produce domestic electricity, and therefore calculations of energy equivalency are beyond the scope of this EIS (see Chapter 1, Section 1.5.3, Issues Eliminated from

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			it is converted into fuel rods. In addition, that data should also be compared to the equivalent amount of coal and oil needed to generate the same amount of power. This will help the average person understand the importance of exploring for and developing this resource,	Detailed Analysis). This section has been expanded in the FEIS to provide specific rationale for elimination from detailed analysis.
Uranium Watch	225262	51	Section 4.3 Geology and Mineral Resources. Pages 4-36 to 4-42. Section 4.3.3 Compliance with Environmental Regulations and Permitting (page 4-38) describes the types of reclamation that will take place at uranium mines.This section should have described the clean up of hazardous radioactive (such as uranium and radium) and non-radioactive (such as arsenic) contaminated materials during site reclamation. This section should have included a discussion of the unique issues associated with the reclamation of uranium mine sites. This section should have included a discussion and assessment of the reclamation of any water treatment facilities at the uranium mines.	Reclamation requirements are specified on a case-by-case basis. Further information has been added to Section 4.3.3 discussing what has been required historically and what is in current proposed plans of operation.
Uranium Watch	225262	52	Section 4.3 Geology and Mineral Resources. Pages 4-36 to 4-42. Section 4.3 should have included an assessment of other uranium mineral resources in the Utah and Colorado area that currently provide, have been permitted to provide, or have the potential to provide uranium ore to the White Mesa Mill. The development of additional uranium mining operations, under Alternatives A, C, and D, should be looked at in conjunction with an assessment of other uranium reserves on private, state, and public lands in the region that can provide uranium ore to the White Mesa Mill. This would include an assessment of the uranium resources associated with the non-breccia pipe mines that are owned by Denison Mines (USA) Corporation and the other uranium resources currently available to DUSA outside the withdrawal area.	The purpose of this EIS is to analyze the impacts of the Proposed Action and alternatives, which is a withdrawal from the mining law of 1872 of approximately 1 million acres in Northern Arizona and two reduced withdrawal alternatives. Comparison of impacts with mining in other areas isn't relevant to the analysis in this EIS.
Uranium Watch	225262	53	Section 4.3 Geology and Mineral Resources. Pages 4-36 to 4-42. The DEIS must assess the environmental impacts associated with the mining of uranium in areas outside the north and south rims of the Grand Canyon in order to provide ore for the White Mesa Mill over the next 20 years. Since there are other sources of uranium ore in the vicinity of the White Mesa Mill, some much closer to the Mill than the withdrawal area, and many of those resources are on public lands, a full assessment of those resources is warranted.	The purpose of this EIS is to analyze the impacts of the Proposed Action and alternatives, which is a withdrawal from the mining law of 1872 of approximately 1 million acres in Northern Arizona and two reduced withdrawal alternatives. Comparison of impacts with mining in other areas isn't relevant to the analysis in this EIS.
Arizona Mining Association	225266	8	Section 2.4.1, Section 4.3.5 and Section 4.3.6 The DEIS does not put into proper context the fact that considerable acreage of land has already been withdrawn in the vicinity of the proposed withdrawal area. As acknowledged in Sections 4.3.5 and 4.3.6 of the DEIS, 50% ofthe 9,100 square miles designated as high mineral potential for uranium in Northern Arizona has already been withdrawn from mineral location and entry. Under the Proposed Action, the land withdrawn would increase by 1,579 square miles to almost 70% of the land with high uranium potential. Furthermore, the withdrawal of 70% of lands with high uranium potential	This information is already considered in the FEIS in Table 4.3-3, which summarizes the percentages of cumulative land withdrawal for all alternatives. It is further described in the cumulative impacts portion of Sections 4.3.5 and 4.3.6.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			does not include large land blocks that various tribes have closed access to under uranium mining moratoriums. As noted in ARPA's comments, this region is one of the most important uranium-producing regions in the United States with nearly a 300-400 million pound uranium endowment according to the BLM and the USGS (Circular 1051). This endowment represents an enormous and vital domestic supply of clean energy at a time critical to the energy needs of the United States. The Proposed Action would require the nation to forego almost half of its uranium resources and force the country to become even more import dependent for this strategic mineral.	
National Mining Association	225281	7	According to the DEIS, the undiscovered uranium endowment in the proposed withdrawal area is approximately 326 million pounds, of which about 33,155 tons (or more than enough to fuel all 104 US reactors for over a year) would be economically viable Furthermore, these numbers do not appear to factor in the Mineral Report conclusion that it is possible the majority of uranium resources on the subject lands have yet to be discovered. There is potentially a large number of hidden breccia pipes that remain to be discovered by advanced geophysical techniques. (Emphasis added.) Mineral Report at p. 22. And the statement on hidden breccia pipes is not speculative: However, the potential to discover additional hidden mineralized pipes with airborne VTEM geographical surveys is high. Hack II, the largest and one of the highest grade uranium deposits ever discovered on the land involved, is a hidden breccia pipe. Mineral Report at p. 27. For reasons unclear to NMA, neither the DEIS nor the Socioeconomic Report track or follow up on the suggestion that there may be a large potential for future discovery of hidden breccia pipes.	With respect to the RFD, hidden breccia pipes are part of the uranium endowment within the project area. As such mining of hidden breccia pipes is already incorporated into all aspects of the DEIS analysis.
Ted Jensen	225282	11	In Minerals section it states that alternatives are "subject to valid existing rights". This needs to clearly state that this means all but very few claims will be considered valid and in effect closes the Arizona Strip.	The commenter is correct that all of the action alternatives analyzed in this EIS will close the lands within the area proposed for withdrawal from location and entry of new mining claims. Determination of how many existing mining claims would constitute valid existing rights is outside the scope of this EIS.
Quaterra Resources, Inc.	242664	2	Two USGS studies have estimated an endowment in excess of 320 million lbs. yet the DEIS has incorrectly referenced a highly subjective and inaccurate comment made over 22 years ago in a single publication with no supporting data to reduce this endowment to a mere 45 million lbs. Even the (August 2010) BLM Mineral Report on the mineral potential of the proposed withdrawal area classifies the uranium potential as (H/D); the highest classification possible for both potential and level of certainty and goes on to conclude, *Failure to develop uranium resources on the subject lands has far reaching economic implications, which are beyond the scope of this report.*	See RFD comment 225256:127
Quaterra	242664	3	The assumption made in the DEIS that uranium pipes are uniformly	See RFD comment 225256:126

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Resources, Inc.			distributed throughout the area and that the potential loss of uranium is directly proportional to the number of acres withdrawn, not which lands are withdrawn is a huge mistake. Nearly all the known mineralized pipes and all of the economically viable uranium deposits in the region have been found in a N-S trending mineralized "corridor" that is approximately 45 miles wide by 110 miles long. The hundreds of pipes mapped outside of this corridor are barren. All of the proposed withdrawal area is within this corridor because the area of proposed withdrawal was selected by drawing a line around the focus of the claim staking activity.	
Quaterra Resources, Inc.	242664	4	Perhaps the most erroneous assumption in the DEIS is that resources of the district are not capable of sustaining mining for 20 years. At an average production of 1.5 million lbs of uranium per year per mine, an average of 3 million lbs produced per mine, and even using a gradual ramp-up of production, six continuously operating mines could produce 160.5 million lbs in 20 years; only one half the total estimated endowment of the subject lands.	This comment misunderstands the USGS endowment figures. The entire uranium endowment includes ore grades down to 0.01%. This is much lower than is considered economic to mine. By contrast, historic uranium mines averaged over 0.5% grade ore, and pipes currently expected to be mined average over 0.25% grade ore.
The NAU Project, LLC	242913	22	Table 1.5-1 Geology And Mineral Resources The energy potential for uranium was never calculated for the withdrawal area or for those areas already cumulatively withdrawn. I did provide analysis for this in my comments for Chapter 3 or 4 or both. This analysis needs to be done as required by NEPA.	There is no guarantee that uranium mined from the proposed withdrawal area would be used to produce domestic electricity, and therefore calculations of energy equivalency are beyond the scope of this EIS (see Chapter 1, Section 1.5.3, Issues Eliminated from Detailed Analysis). This section has been expanded in the FEIS to provide specific rationale for elimination from detailed analysis.
The NAU Project, LLC	242913	28	Page 3-5 Table 3.1-1 3.3 Geology and Mineral Resources Issue: Depletion of uranium resources. Mining these uranium deposits in the near future depletes domestic resources that may be needed later for energy production or national security purposes. The U.S. Government has all the uranium and plutonium that it desires for national security purposes and by treaty must down blend some of it and turn it into fuel for nuclear power plants. Therefore, the uranium in the withdrawal area is not needed for national security purposes. The U.S. imports nearly all of our uranium now, so saving in ground domestic supplies for later doesn't make too much sense when the goal is to become energy independent now. Any discussion of the above issue should recognize these facts.	This comment is non-substantive. It does not question the accuracy of information used, the adequacy of specific assumptions or methodology, provide new information, or offer reasonable alternatives or changes to alternatives. However, note that these concerns are discussed in great detail in other comments.
The NAU Project, LLC	242913	32	Page 3-32 The uranium deposits within the northern Arizona breccia pipes are of higher grade than approximately 85% of the world's known uranium deposits (International Atomic Energy Agency 2009; World Nuclear Association 2009). It should be acknowledged here that the breccia pipe uranium deposits are considered world class and have attracted exploration and mining interest from all over the world and from across our country.	This comment is non-substantive. It does not question the accuracy of information used, the adequacy of specific assumptions or methodology, provide new information, or offer reasonable alternatives or changes to alternatives. However, note that these concerns are discussed in great detail in other comments.
The NAU	242913	33	Page 3-37 to 38 : Cumulative Withdrawal of High Mineral Potential Lands.	The conversion of acres withdrawn into tons of

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Project, LLC			This section gives no context as to what amount of uranium these cumulatively withdrawn areas represent. The 5100 square miles represents 73,899 short tons of U3O8 and this figure needs to be included in the discussion.	uranium would be not be possible since not all of these withdrawn areas are covered by existing studies (i.e., Finch 1987).
Janet Remington	244004	2	How many individuals or corporations have filed claims to mine uranium in or near the Grand Canyon?	The purpose of this EIS is to analyze the impacts of the Proposed Action and alternatives, which is a withdrawal from the mining law of 1872 of approximately 1 million acres in Northern Arizona and two reduced withdrawal alternatives. Identification of the individuals or corporations holding mining claims isn't relevant to the analysis in this EIS.
Joseph Turner	246049	5	UNe have assumed that uranium yellowcake will sell for a baseline average of $40/lb. Hard-rock minerals are known to boom and bust, this should be mentioned when explaining 'the use of a baseline]	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim management.
Joseph Turner	246049	6	Why not look at all the reasonable scenarios that might cause these mines to be "mothballed?" Specific examples that do not seem so far fetched are: 1) nuclear accidents (especially now, but no less before this month tragedy) 2) hard-rock mining reform bills similar to ones that have passed the house as late as 2008 (there are not that many variations, basically would these mines operate at the 40$ price if they had to pay royalties) 3) litigation or heavy pressure on local agencies to deny permits (how long are the permits good for and is it possible to be legally embroiled. Even if you can not explore these scenarios, could you develop a generic scenario were the price dropped or the net profitability dropped? The specifics of these scenarios aren't essential, their affect on demand, and thus price, is. Could you publish a predicted figure for the price of uranium that would probably cause a scenario where mining and exploration in the region would stop.	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim management.
Joseph Turner	246049	7	These pipes are localized and the public would at least like to be better informed. Disclose the exact location of as many of the 30 mine locations, as well as the unavoidable, but not explicitly disclosed "nine mines" that are on the way no matter the decision of the agency on the withdrawals. In other words characterize the science based potential for each possible	The majority of the mines that are estimated to be developed are based on as-of-yet undiscovered breccia pipes. There is no reasonable way to estimate where these mines might be. Even with respect to known deposits, it cannot be stated for certain that

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			exploratory sites with an active claim on the exclusion areas that can not be stopped under existing laws, and if they can not be ruled out, please do not estimate a figure of 30 mines (the probabilities of water and air contamination depend on it), cite instead the potential of all valid claims. It seems quite possible figures could grow enormously if there are 1000 sites and say that 15% have economically extractable resources instead of 3%, that could more than double the mining activity here. These deposits have been known to yield more uranium than was previously thought too, so maybe we should error on the side of the miners proceeding at more sites.	these deposits will result in operating mines since any mining claims covering such deposits would still be required to demonstrate valid existing rights prior to approval of a mining plan of operations. The only mines that can be located with any certainty are the four mines with approved plans of operation, and these have been specifically identified. These mines are already located in the FEIS on Figure 3.4-1.
Alicia Sullivan	102970	1	After reviewing the document I have a concern around the analysis of the surface area disturbance for alternative A on page B-35 and B36. In the paragraph at the bottom of page B-35 the document states that "Acreage disturbed includes the footprint of the mines themselves and the acreage disturbed by new roads, new power lines, and exploration activities. Estimates of the acreage disturbed by each mine footprint vary from 3 to 4 acres per mine (Wenrich 2009) to approximately 15 to 20 acres per mine (personal communication, Spiering 2010d) to more than 40 acres per mine (Denison 2010)." However in the analysis, an assumption of 20 acres was used to calculate the surface disturbance. Given the statement above, especially in regard to the the comment that a mine may be greater than 40 acres, I think that using an assumption of 20 acres is misleading and is potentially providing inaccurate and low estimates of surface disturbance. There should be a way to estimate the mine size and surface disturbance based on the explorations and number of breccia pipes found on a site rather than making an assumption about it. What data is available to provide information to do this, has this been researched? Is there an estimate of breccia pipes for each proposed site? How much surface disturbance is there for a mine of a similar type other place in the US or worldwide? I believe that this could be quantified more accurately and with less variation than what has been provided.	The commenter assumes detailed information is available for each of the proposed mine sites; this is not the case. Most of these mines sites are based on as-of-yet undiscovered breccia pipes. The use of the 40 acre number is taken out of context. As explained on page B-36 of the DEIS, the high end number refers to a site where several breccia pipes are to be mined (EZ-1, EZ-2, What). The average acreage per breccia pipe at these multiple-pipe sites (13.3 acres per pipe) is actually less than the average of 20 acres that was used for the RFD, not more. Overall the RFD was based on the simplifying assumption that one mine equals one breccia pipe. The surface acreage disturbed is more than likely overestimated due to this assumption. If multiple pipes are developed per site, acreage will actually be smaller and fewer roads will be constructed.
Alicia Sullivan	102970	2	Also in regard to the surface area disturbance analysis for roads (page B-34), the surface area should also include turn outs and take into account the topography that the road will be built on. While the addition of 50% to the average distance was added to try and account for this, a through GIS analysis based on a Digital Elevation Model or contour map could easily determine the exact distance from the theoretical mines to the existing road network.	Such a detailed analysis assumes that the locations of those mines will be known exactly. On the contrary, the locations of only four of the mines are known with certainty.
Alan Kuhn	87261	1	The methodology and conclusions in this DEIS are flawed. The DEIS ignores the fact that modern exploration, mining, and reclamation techniques are protective of the environment when applied properly, and the actual footprint of uranium or other mineral development in the subject area is very small and quite manageable with modern methods.	The regulatory framework established to protect the environment is described in Appendix B, RFD Scenarios, section B.3.1.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Arizona State Land Department	225280	11	In Subsection B.1.3, Study Area, Tables B-1 and B-2 on page B-3 include seven or so uranium mines that were active, primarily during the 1980's. Were there any problems or issues with any of these mines that would justify the present level of concern necessary for the proposed withdrawal?	This information is not pertinent to the RFD. However, note that the legacy of these mines was discussed in detail in the DEIS on pages 3-57 through 3-60, and on page 3-85. Discussion of effects on soils and stream sediments from these historic mines is given in the DEIS section titled "EFFECTS FROM HISTORIC (1980s) MINING", pages 3-102 to 3-108. This discussion draws primarily from Otton et al (2010). No definitive impacts to water resources have been determined from these (1980s-era) historic mines. However, Appendix G discusses impacts to groundwater and surface waters associated with the Orphan Lode mine.
Arizona State Land Department	225280	12	In Section B.4 on page B-10, the RFD notes that there are six stages in the development of a uranium mine, but there are seven bullet points listed.	The text in Section B.4 has been changed to reflect seven stages.
Arizona State Land Department	225280	13	In Subsection B.4.1 on page B-11 , the RFD notes that the first breccia pipes were originally discovered as a result of their exposures in the walls of the canyons. However, there is no discussion anywhere within the RFD or the DEIS of how many pipes are naturally exposed within, and how much uranium is consequently being naturally eroded and released into, the Colorado River watershed. The Arizona Geological Survey (AGS) did a recent study of these naturally exposed breccia pipes, and found that the amount of uranium naturally eroding into the watershed from these exposed breccia pipes would greatly exceed any accidental release of uranium from mining activity.	This information is not pertinent to the RFD. However, note that the impact of exposed breccia pipes on water quality is discussed on page 3-78 of the DEIS. Section 3.4.4 (page 3-57) of the DEIS provides some discussion of natural release of uranium into the environment from breccia-pipe ore bodies. The number of known breccia pipes exposed is discussed on page 3-57 and these pipes are shown on Figure 3.4-5. Breccia pipe uranium deposits appear to be the source of widespread low to moderate concentrations of dissolved uranium in groundwater throughout the region. The continuum of conditions at breccia pipe ore deposits in the study area may be divided into three broad categories. In the first case, where breccia pipes and especially their ore bodies have been exposed in canyon walls for a significant amount of time, the uranium ore has largely been removed prior to modern times by oxidized surface waters and groundwaters. Exposure of breccia pipes in canyon walls results in accelerated weathering and fracturing of the pipe that provides significant routes of access for water to dissolve and leach minerals out of the ore body. In the second case, where breccia pipes or their ore bodies are not significantly exposed, far less contact with migrating water is possible; this condition results in slow and longer term release of uranium into the groundwater or surface water. In the third case, as described in Section 3.4.4, breccia pipes containing

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				economically viable uranium ore that could be targeted for mining in the study area are generally characterized by well-cemented, very low permeability breccias and adjacent formation rocks, which do not permit the flow of groundwater through the tightly locked mineral deposits. This condition inhibits dissolution of mineral deposits associated with these economically viable breccia pipes into groundwater. The article referenced by the commenter (Spencer and Wenrich 2011) discusses background concentrations of dissolved uranium in the Colorado River. Although some influx of dissolved uranium to the river occurs in the study area as a result of natural erosion of uranium deposits in the Grand Canyon region, only a very small fraction of the uranium in the river is contributed from streams and springs originating in the Grand Canyon. Nearly all of the uranium load in the Colorado River in Grand Canyon is derived from areas upstream of the study area.
Arizona State Land Department		14	The last two sentences in Subsection B.4.5 on page B-15 are either confusing or meaningless. Are levels of uranium above background unacceptable or not since they are below levels for which ADEQ requires remediation? If the levels are acceptable, what is the point of mentioning this?	There is a difference between regulatory jurisdiction and disclosing impacts. The identification of uranium levels above background concentrations is pertinent to disclosing impacts from known uranium mines that may require reclamation, even though they may not exceed limits under Arizona regulations. It should be noted that the RFD (Appendix B) is not meant to cover this topic in detail. Rather, this topic is discussed in full detail in Section 3.5 of the FEIS. The text cited does not establish a value judgment regarding levels of uranium that are in excess of background. The ADEQ remediation standard applies to non-residential areas and is used to quantify impacts in DEIS Chapter 4 (pages 4-97, 4-98, 4-104, and 4-105 of the DEIS). Levels of uranium in excess of background, but less than 200 ppm may have specific consequences for other resources, such as wildlife.
Arizona State Land Department	225280	15	In Section B.5 on page B-17, the RFD reports approximately 5,300 claims within the three withdrawal parcels. It would seem appropriate to reference here the discussion on pages B-23 and B-24 of Known Mineralized Breccia Pipes with No Estimate of Uranium Resources and Known Mineralized Breccia Pipes with Underermined Mineralization, respectively, that a very small percentage of these claims will actually result in mines. Similar to the discussion on pages B-23 and B-24, the ASLD's experience	See RFD Comment 242664:9

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			is that only one or two in ten exploration projects proceed to the development stage, and only one or two in ten development projects then proceed to become an actual mining operation. Thus, the number of claims is on the order of 50 to 100 times higher than the number mines that will ever be developed. This is a point which should be stressed. Many statements from some groups regarding the proposed withdrawal indicate that they assume ALL mining claims are going to result in actual mines. This is, of course, far from the reality.	
Arizona State Land Department	225280	16	There should be some discussion in the RFD or the DEIS about how long it would take to establish valid existing rights for all of the mining claims	The selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations. From that time, it can take a minimum of 6 months to several years to complete a validity determination.
Arizona State Land Department	225280	17	In Subsection B.7.1 on page B-18, the RFD notes that the value of other commodities or metals that could be recovered during the mining of the breccia pipes would not be sufficient to drive mine development. However, the rare earth elements were not specifically listed as one of the other metals. Several sample analyses that the ASLD has seen from some of the exploration projects in the breccia pipes on the Colorado Plateau recorded high concentrations of rare earth elements. With the current world-wide interest in and demand for the rare earth elements, the breccia pipes could represent a potentially valuable source.	See RFD Comment 242664:8
Arizona State Land Department	225280	18	In Subsection B.7.2 on pages B-18 thru B-20, the RFD assumes that the price of uranium will remain stable at around $40/lb. over the 20 years of the proposed withdrawal. The limited, 15-year range of price history shown on Figure B-4 might mislead anyone not familiar with mineral commodity prices in general and uranium prices in particular. If the price history were traced back to approximately the same time-frame as that used for production history shown on Figure B-3, the earlier ups and downs of the price of uranium would be seen, especially the rise in the 1970's and the dramatic fall in 1979 and 1980 after Three Mile Island. There should also be some discussion of the price of uranium being kept artificially low and stable throughout most of the 1990's to around 2005 by the reprocessing of uranium from the nuclear weapons in the arsenals of the former Soviet Union. On the futures end of uranium prices, since this section was written, probably in mid to late 2010, the price of uranium has already increased dramatically from the $40/lb. level. The spot price for uranium hit $72/lb. in January 2011 before falling to $69/lb. in February 2011. And while the spot price fell even further to about $57/lb. by the end of March following the disaster at the Fukushima plant in Japan, it has generally rebounded to	For the purposes of the RFD, the price of uranium was assumed to remain at or above current levels and therefore high enough to allow development of breccia pipes. There are no cost prohibitions in the RFD that would limit development. Prices above $40/pound would not necessarily result in changes to the RFD scenario. This is because under the assumptions used in the RFD, the limiting factor in development of uranium resources was determined to not be the industrial capacity to mine uranium, but the physical amount of uranium available to be mined.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			trade in the mid $50/lb. to low $60/lb. range thru April. All of these recent prices are well above the $40/lb. level assumed in the RFD.	
Arizona State Land Department	225280	19	Also in Section B.8.1 on page 8-25, in the discussion of Undiscovered Uranium Resources the RFD references the Finch, et al. 1990 USGS Circular 1051 report. In the USGS Scientific Investigations Report 20I 0-5025 , several of the figures from Finch, et al. 1990, were reproduced in Chapter A on uranium resource availability, specifically Figures 3 and 5, and it might be helpful to repeat those figures here. On page B-28, it refers to Figure B-5, but the report skips from Figure B-4 to B-6 and it is not clear if it is really Figure B-6 that is being referenced. Also on page B-28, in discussing Uncertainty Factors in Commodity Prices, the RFD refers to uranium prices recovering at the end of the 1990's as shown on Figure B-4; however, Figure B-4 does not start showing uranium prices until 1995 and it doesn't look like there is any real recovery in price until 2003 or 2004. This is another reason to show the earlier price fluctuations in Figure 8-4, as commented on earlier.	Figure B-5 has been added to Appendix B of the FEIS.
Arizona State Land Department	225280	20	At the end of the RFD, in Table B.1-1, with the exception of mentioning the hauling of explosives regulated by the ATF, there is no mention of hauling or transportation licenses or permits. At the Arizona Department of Environmental Quality's (ADEQ) recent public meetings and hearings for air and water quality permits for Denison's Canyon, EZ and Pinenut Mines, many of the questions and concerns raised by the attendees regarded the truck traffic and hauling. The relative disappearance of transportation as an issue for the DEIS is even more surprising since it was identified as a main issue during the public scoping process (page 2.2). The only other real mention of transportation is in Table 2.8-1, where on page 2-43 the table notes that the 22.4 miles of new roads would benefit driving for pleasure, and on page 2-45 where the table notes that the mining companies would be responsible for maintenance of unpaved public roads used for hauling. Another issue for hauling is rights-of-way across nonfederal lands. For any new roads associated with new mines that would cross non-federal lands, a right-of-way agreement would be required with the land owner, either the ASLD or the private entity. In the case of a withdrawal, the converse is whether a mine operator on ASLD or private lands would be able to obtain a right-of-way across the federal lands that are now closed to location or entry.	The haul trucks are designed such that the material being transported is covered and sealed; therefore, emissions from the ore being hauled are not allowed to escape the vehicle as a fugitive source. It is the applicable regulatory agency's responsibility to protect human health and the environment. Each site-specific mine plan will include mitigation and control measures for the transportation of uranium ores from the mine site to the processing facility. Language has been added to EIS Section 3.2.2., Legal and Regulatory Requirements, to identify the applicability of 49 CFR Part 171, 172, and 177 to the transport of uranium ore from the mine location to the processing facility. Transportation conflicts are discussed in Chapter 3, Section 3.16, under Public Health and Safety, and potential impacts are discussed in the Public Health and Safety section of Chapter 4, Section 4.16. Neither the proposed withdrawal nor any alternative withdrawal would have any effect on rights-of-way (ROWs) or access to non-federal lands within the project parcels. ROW applications would continue to be processed as before. The FEIS has been revised to provide clarification on this issue.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Mitigation and Monitoring				
LO I & Won Yin	50531	2	In the final decision, we would like to see a statement of what BLM will do to identify and cancel fraudulent mining claims - those that have no valuable mineral deposit. We would not be surprised if most of the existing claims were bogus.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations.
Lynn Hague	54297	2	Please include a program to challenge all existing mining claims that lack a valid mineral discovery. Any claim that has no valuable mineral deposit can be cancelled, and thereafter the claimant has no right to disturb the land in any way. Many of the existing claims undoubtedly were speculative, without any proof of minerals.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations.
Elizabeth Robinson	54302	2	The final EIS should include a plan for BLM to challenge claims that have no valuable mineral deposit. Such claims should be contested and cancelled, so there can be no damage on those sites.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations.
Jan & Gayla Kobialka	54305	2	We notice on the map that hundreds of mining claims were staked before the area was closed by Secretary Salazar's emergency order 2 years ago. We urge BLM to challenge those claims and cancel those that do not qualify under the mining law by having a valuable mineral deposit.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations.
Larry Laffoon	54306	2	To support the withdrawal, BLM should contest all existing claims that lack a valuable mineral deposit. No doubt many claims do not meet the Mining Law's standard and can be invalidated before any damage is done.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations.
George & Lauria Riley	54314	2	BLM should check every existing mining claim and, if it lacks a valuable mineral deposit as the Mining Law requires, it should be cancelled. Many if not most of the mining claims are probably not valid.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				will be determined at the time that the operator submits a notice or a plan of operations.
George & Lauria Riley	54314	3	For those claims that prove to be valid existing rights, **BLM should undertake to acquire the rights by exchange or buyout.** No new mines should be allowed in the withdrawal area if there is any possibility of acquiring the rights.	The purchase of valid mining claims by the Federal Government is out of scope of the analysis of this EIS. This EIS analyzes the impacts of a mineral withdrawal. Acquisition of property rights subsequent to any decision to administratively withdraw these lands is outside the scope of the analysis of this EIS.
George & Frances Alderson	54360	2	No doubt the RFD figures are based on a presumption that certain claimants hold valid existing rights as of the date of the segregation in 2009. BLM should develop options to avert those impacts and present recommendations to the Secretary of the Interior and Congress if legislation is necessary. These options could include: contest all mining claims and cancel those that lack a valuable mineral deposit; **buy out the rights of any valid claims that remain**; **exchange the mineral rights for BLM public lands outside the withdrawal area; exchange the mineral rights for rights under the Mineral Leasing Act** for coal, oil, gas, phosphates or sodium, on BLM public lands outside the withdrawal area.	This EIS analyzes the impacts of a mineral withdrawal. Acquisition of property rights subsequent to any decision to administratively withdraw these lands is outside the scope of the analysis of this EIS.
Anonymous	61987	1	I am writing in favor of carefully regulated mining in the Grand Canyon. We need to preserve the Grand Canyon as a national monument, but I am not in favor of that putting mining completely off limits. If penalties for polluting are sufficiently high to begin with, I believe that mining can and would be undertaken in a way to preserve the Grand Canyon and still allow us to benefit from its natural mineral resources.	The alternative for promulgation of surface management regulations specific to the withdrawal area is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis. Regardless of the alternative selected by the Secretary of Interior, appropriate rule making could be undertaken.
Robert Pearson	98237	1	Any future mining developers must be made to establish a major cleanup & rehabilitation fund adequate to cover all foreseeable costs to the affected watersheds. Funded prior to and development work. Funds to be jointly managed by EPA & BLM.	Mining operators within the withdrawal area are currently required to post a bond prior to mining activities. The bond is a financial guarantee that provides assurance that the operator will fulfill reclamation obligations as outlined in their mining permits.
Denison Mines Corp	104145	2	Current regulations, including both State and Federal, provide more than adequate protection of the Grand Canyon watershed. If additional safe guards are needed for specific areas, then these can be better addressed by promulgating surface management or other regulations specific to areas adjacent to the Grand Canyon.	The alternative for promulgation of surface management regulations specific to the withdrawal area is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis. Regardless of the alternative selected by the Secretary of Interior, rule making could be undertaken.
Denison Mines Corp	104145	3	Denison strongly believes that the values of Grand Canyon National Park must be protected. There can be no question about that. However, there already exists, without the proposed withdrawal, the protections in place to ensure the park is protected while allowing the development of critical domestic mineral resources. Existing law, including the Clean Air Act	The EIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable Development Scenarios, Section B.3, Regulatory

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			(CAA), the Clean Water Act (CWA), the Federal Land Policy and Management Act (FLPMA), the National Environmental Policy Act (NEPA), and Forest Service and Bureau of Land Management policies, as well as applicable state and local permitting and financial assurance requirements provide sufficient authorities and tools for the protection of resources while providing for multiple use of the area.	Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
Albert Banwart	192975	1	If mining is allowed it should only be under specific conditions: 1) No surface or ground water can be disturbed; 2) Once mining is begun, a suitable bond must be posted to cover any cleanup (e.g., 1million - 1 billion dollars per acre, with the premiums paid for at least 25 years, which can be ended once mining has ended and all cleanup is complete; and 3) Water leaving the mining area must be as good, or better, quality than when it entered.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Maryland Ornithological Society	213913	2	All seven new mines predicted for Alternative B are within the North Parcel. These should be reduced to zero, if possible, leading to corresponding reductions in impacts of roads, surface disturbance, etc. Possible approaches include: **(1) buying-out the mineral rights, (2)exchanging the rights for federal lands elsewhere, or (3) exchanging the rights for mineral rights under the Mineral Leasing Act of 1920 (generally fossil fuels, phosphates, and sodium).**	This EIS analyzes the impacts of a mineral withdrawal. Acquisition of property rights subsequent to any decision to administratively withdraw these lands is outside the scope of the analysis of this EIS.
Maryland Ornithological Society	213913	3	We also urge BLM to carry out an aggressive program of cancelling non-valid claims. A mining claimant under the Mining Law has rights against the United States Government only when a valuable mineral deposit has been discovered on the claim. The BLM should investigate all claims that had been staked before the segregation took effect on July 20, 2009. Any claim that lacks a qualifying mineral deposit should be cancelled. Fluctuations in the uranium market are pertinent. To be valid, a claim must have had a mineral deposit that was valuable at the time it was staked and that was still valuable on July 20, 2009. A graph in Appendix B indicates that uranium market prices were much lower in 2009 than in 2007-2008 (EIS, Figure B-4 at page B-20). Claims that were valid in 2008 may have lost validity before the segregation took effect.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations.
Roland Maldonado	213918	1	The need for radiation monitoring along the haul route, both north and south of the canyon, is a first and best line of defense against radiation poisoning.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Roland Maldonado	213918	2	Monitoring for radon gas is inadequate, as it dissipates fairly rapidly. The contracts, or your agreements of understanding, do not address these issues. Your regulatory authorities have no real authority to enforce any of these issues. They should be part of their agreements of understanding.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Roland Maldonado	213918	3	There needs to be a timeline of reclamation when a mine is on stand-by so we do not have material lying about for years and/or decades, as is the case with Kanab North. Stand-by should not be an open-ended situation.	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim management.
Roland Maldonado	213918	4	Halo effect of contamination of the mine and surrounding area should not be once the mine closes, but should be an ongoing inspection item. Contamination does not happen after the mine closes, it happens during operations. This is one way of monitoring actual effects and contaminations.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Donna Brown	225253	2	I also believe that BLM should conduct validity exams on all existing mining claims within these segregation areas to ensure that those claims are legally valid in terms of having commercially valuable deposits.	Selection of one of the withdrawal alternatives does not require the government to immediately begin validity examinations on all of the mining claims within the withdrawn areas. Rather, if the Secretary selects any of the withdrawal alternatives, mining claim validity will be determined at the time that the operator submits a notice or a plan of operations.
Donna Brown	225253	3	We are told that modern environmental inspection and compliance processes, and perhaps also bonding requirements, will prevent any past contamination problems from reoccurring. However, many of these same environmental inspection and compliance processes are now under attack politically and/or their budgets are being drastically cut. Indeed, the Arizona Department of Environmental Quality (ADEQ), which has delegated authority from EPA to administer permits and conduct inspections under the Clean Air Act, Clean Water Act, and perhaps other federal environmental and public health laws, recently announced that due to budget cuts it is closing its Flagstaff office.	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. The BLM and Forest Service regularly inspect mining operations. The BLM, under the 3809 Surface Management Regulations, inspects active operations two times per year, at a minimum, and conducts more frequent inspections when necessary. The minimum number of inspections for active operations on Forest Service lands is one time per year with more frequent inspections when necessary.
Donna Brown	225253	4	The capacity or ability of government to serve as an objective, effective, or even minimally reliable "watch dog" is rapidly diminishing. How often will ADEQ inspectors from Phoenix drive up to the Arizona Strip to inspect uranium mines for any potential radioactive and/or heavy metal discharges? Since the Arizona I mine re-opened, how many such ADEQ inspections have already occurred? Does BLM conduct any such inspections, and, if so, how many have occurred in recent years, how many inspectors does BLM have, and what are the relevant qualifications of any BLM inspectors? My point is that those who were handed by past broken promises should not accept new promises unless there are ironclad legal commitments, and adequate funds and staff, to guarantee that those promises can and will be fulfilled.	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. The BLM and Forest Service regularly inspect mining operations. The BLM, under the 3809 Surface Management Regulations, inspects active operations two times per year, at a minimum, and conducts more frequent inspections when necessary. The minimum number of inspections for active operations on Forest Service lands is one time per year with more frequent inspections when necessary.
Donna Brown	225253	5	I doubt that sufficient bonds would be posted in the event of a low probability but high severity event, like the inadvertent contamination of an aquifer. Indeed, some contamination may be irreversible from a practical standpoint, and no amount of money could reverse the damage. At the point that it is discovered that some precious Grand Canyon seeps and springs are poisoned, it would likely be too late to stop further contamination, and many native species dependent on those seeps and springs could be lost with no practical way to save them or compensate for their loss.	Mining operators within the withdrawal area are currently required to post a bond prior to mining activities. The bond is a financial guarantee that provides assurance that the operator will fulfill obligations as outlined in their mining permits. NEPA does not require a worst-case scenario analysis (this analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618, Apr. 25, 1986), only analysis of circumstances that are reasonably foreseeable is required. Appendix B provides this reasonably foreseeable development scenario and provides a rationale to why this scenario is used.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Uranium Watch	225262	67	The DEIS fails to consider other remedial standards that could be applied by the BLM to the reclamation of mine sites on BLM land. The DEIS must consider establishing a more stringent remedial standard for reclaimed uranium mines on BLM and USFS land.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Arizona Mining Association	225266	3	There are no significant environmental reasons for the withdrawal because there are existing laws and regulations that adequately protect the environment. These laws, including the Clean Air Act (CAA), the Clean Water Act (CWA), the Endangered Species Act (ESA), the Federal Land Policy and Management Act (FLPMA), the National Environmental Policy Act (NEPA), the National Historic Preservation Act (NHPA), the Arizona Environmental Quality Act which authorized Arizona's Aquifer Protection Program (APP), the Forest Service (USFS) and Bureau of Land Management surface management regulations and policies, as well as applicable state and local permitting and financial assurance requirements, provide sufficient legal authorities and tools for the protection of all environmental resources while providing for multiple-use of the area.	The EIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable Development Scenarios, Section B.3, Regulatory Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
Pew Environment Group	225274	9	While it may be too late to truly understand the impact of past mining operations, we urge the BLM to make additional investigations a priority. We believe that the withdrawal period offers a reasonable window for developing the knowledge and baseline data that are needed to protect the water resources that run through this vulnerable area with its complex interplay of groundwater and surface water and a multitude of fractures, faults, sinkholes and other features that can serve as conduits for contaminant movement.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
National Mining Association	225281	11	We request BLM review the impacts of the proposed withdrawal given its multiple use mission under FLPMA. The agency can take other less restrictive measures to protect park resources, such as those outlined in BLM's RMP for the Arizona Strip.	As requested, this EIS does review the impacts of the proposed withdrawal. Section 1.3 of the EIS explains the purpose and need of this document. The decision to be made is whether or not to withdraw the area from the Mining Law of 1872, subject to valid existing rights. This EIS is being prepared to help inform that decision.
David Kreamer	227290	3	I believe current monitoring and proposed monitoring associated with	The purpose of the EIS is to analyze the effects of the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			future mining activities is inadequate, and not in line with what is required of other potential contaminant sites and normal, diligent industry practices.	Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Doug Reagan	242175	4	Mitigation measures are vague and do not adequately specify how they will be implemented or monitored. Criteria for achieving adequate restoration should be stated, and provision for adequate restoration monitoring should be specified.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Arizona Raft Adventures & Grand Canyon Discovery	242647	3	Consequently, as an amendment to the proposed 20 year withdrawal as outlined in Alternative B, we believe the implementation of a region- wide groundwater monitoring program is appropriate, given the limited timeframe of the withdrawal and the potential for mining's impacts in the future.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Grand Canyon River Guides, Inc.	242649	2	We find the lack of oversight, the insufficient environmental safeguards, and the absence of a scientifically credible and comprehensive monitoring program to be unacceptable, placing the burden of risk from any potential contamination on the public and on Grand Canyon itself.	The alternative for promulgation of surface management regulations specific to the withdrawal area is discussed in Section 2.3 Alternatives Considered But Eliminated From Detailed Analysis. Regardless of the alternative selected by the Secretary of Interior, rule making could be undertaken.
Grand Canyon River Guides,	242649	3	Consequently, as an amendment to the proposed 20 year withdrawal as outlined in Alternative B, we believe the implementation of a region-wide	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Inc.			groundwater monitoring program is appropriate, given the limited timeframe of the withdrawal and the potential for mining's impacts in the future.	withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Mary Crow-Costello	242652	6	Monitoring & Enforcement: What type of monitoring would be conducted? Would the state of Arizona be relied upon to conduct monitoring and enforcement? How can public lands and resources be protected with the lax or nonexistent monitoring and enforcement that Arizona's DEQ has already demonstrated? What would happen if the Arizona legislature cuts funding for monitoring and enforcement?	The BLM and Forest Service regularly inspect mining operations. The BLM, under the 3809 Surface Management Regulations, inspects active operations two times per year, at a minimum, and conducts more frequent inspections when necessary. The minimum number of inspections for active operations on Forest Service lands is one time per year with more frequent inspections when necessary.
The NAU Project, LLC	242913	74	The DEIS doesn't satisfy the requirements of NEPA regarding mitigating measures. It seems that for the most part, the mitigating measures considered are the Alternatives themselves. This is hardly in accordance with NEPA. Mitigating measures should be developed and proposed as required by NEPA for those impacts identified for which current mitigating practices are insufficient and where new practices will result in lower impact levels. Only a few of the Issues analyzed for impacts offered mitigating measures in and of themselves. Most mitigating measures identified are measures already being implemented. The NEPA process requires the identification of mitigating measures be made for each of the issues identified and analyzed if mitigating measures can be developed. From Question 19 of Forty most asked NEPA questions: All relevant, reasonable mitigation measures that could improve the project are to be identified, even if they are outside the jurisdiction of the lead agency or the cooperating agencies...Because the EIS is the most comprehensive environmental document, it is an ideal vehicle in which to lay out not only the full range of environmental impacts but also the full spectrum of appropriate mitigation. The mitigation measures discussed in an EIS must cover the range of impacts of the proposal. The measures must include such things as design alternatives that would decrease pollution emissions, construction impacts, esthetic intrusion, as well as relocation assistance, possible land use controls that could be enacted, and other possible efforts. It is my suggestion that each impact section in Chapter 4 have its own Mitigation Section which discusses the mitigation methods already in use and whether they are considered adequate as currently used. In addition would be any new mitigating measures that could be	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			implemented that would help mitigate projected impacts for that particular impact category.	
U.S. Fish and Wildlife Service	242660	1	Areas of uncertainty include the unknown specific locations of exploration activities and mines during the 20-year period of analysis, the size of ore bodies (and consequently depth, size, and duration of mining activity), the number and duration of periodic episodes of temporary closure of mines (interim management) that may occur in the future, and future activity associated with valid existing claims. There is also uncertainty in the analysis because we simply do not have long-term data nor consistent monitoring of water quality and quantity on a broad enough scale to provide a conclusive evaluation of potential risk to these resources. Lack of toxicity information and radiation hazards associated with uranium on fish and wildlife species local to this area make it difficult to meaningfully assess risk and potential impacts. Therefore, we concur with research suggestions that USGS outlines in their report (Alpine 201 0) and recommend incorporating a federally-led research and monitoring program that will in help to fill some of the data gaps identified in the "Incomplete or Unavailable Infonnation" sections of the analysis, particularly those associated with potential impacts to water resources and chemical and radiation hazards to fish and wildlife and special status species. We also recommend incorporating a long-term and comprehensive monitoring plan focused on evaluating past, current, and future mining impacts.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Fish and Wildlife Service	242660	2	For the impact analysis in Chapter 4, the DEIS relies on the assumption that state and Federal regulations have been and are being met in order to minimize environmental impacts to various resources (e.g., air quality on page 4-17, water quality and quantity on page 4-57, Compliance with Environmental Regulations and Pennitting on pages 4-66 to 67). However, a recent media report (Arizona Daily Sun, March 11,2011, "Three uranium mines advance") states that Arizona Department of Environmental Quality (ADEQ) did not inspect the currently-operating Arizona 1 mine until it had been open for nine months, and that four "major" violations were not addressed. In addition to testing this assumption, longer-tenn and comprehensive monitoring would also serve to evaluate the potential effects that may result from variations in regulatory compliance.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Arizona Geological Survey	225263	2	In our discussions with companies engaged in exploration for uranium in northern Arizona, we have learned of innovative, but common-sense approaches to mining of breccia pipe deposits that have the potential to minimize, mitigate, or avoid many of the fears raised. Some of these include: Limiting the surface footprint of a mining project to perhaps 5-10 acres Creating berms or similar barriers of natural materials to hide operations from view Refilling breccia pipe mines with waste rock mixed with a concrete or similar slurry to seal the shaft, preventing rainfall and surface runoff from entering the mine and thus protecting groundwater resources Require surface restoration such as has occurred at the Pigeon	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate,

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Mine.	could be considered for incorporation into relevant land use plans.
Arizona Game and Fish Department	242655	4	We encourage the BLM to develop a programmatic invasive species weed treatment document like the Forest Service (FS) has done (2005) so that weed treatments can be handled aggressively, and at larger landscapes than individual projects usually allow.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Arizona Game and Fish Department	242655	7	The determination of whether a site has been reclaimed also seems to vary when it comes to mining activities. While many of the previous mines from the 1980's such as Hack Canyon and Pigeon Mine have recovered well, the current landscape has new challenges, such as invasive weeds, that might make reclamation more difficult. The Department remains concerned over the process of reclamation and is willing to engage in the process to ensure that a qualified habitat specialist or botanist determines whether or not reclamation is sufficient prior to the release of the bond.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Arizona Game and Fish Department	242655	8	A solution for addressing topics such as exploratory drilling footprints and reclamation processes would be for the Department to engage in a more formalized process for developing standardized Best Management Practices (BMP's). It is our understanding that BMP's are usually created on a site by site basis as projects arise. However, more standardized BMP's could alleviate some of the concerns for wildlife impacts discussed earlier. We recommend that a collaboratively-based programmatic BMP document be drafted with Department participation.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Arizona Game and Fish Department	242655	10	The Department strongly recommends that under any Alternative a research and monitoring program be established. In addition to the USGS research already underway, the Department's Research Branch would be willing to assist the BLM and FS with research needs. Suggested topics of research and monitoring include:	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Effects to big game habitat use with increased mining activity, Effects of increased traffic on wildlife movement, Effects of uranium mining on surface water resources, both in terms of availability and toxicity to wildlife, Levels at which disruption and reduction in habitat quality lead to habitat fragmentation for wildlife species.	is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plan.
Coconino County Board of Supervisors	225238	14 / 15	There is apparently no required monitoring of soils along all of the haul routes for any potential increase in radioactivity levels. The haul route from each of the three areas to Blanding involves a trip of hundreds of miles, in most cases involving trucking through established communities such as Fredonia, Kanab, Flagstaff, Page, Cameron, Tuba City and Kayenta. Monitoring of soils along the roadsides over all of the haul routes would be a daunting task, but one that should be required as part of the ongoing mining process by the companies or by the Arizona Department of Environmental Quality.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Coconino County Board of Supervisors	225238	16 / 17	Long term cumulative impacts on soil quality and radioactivity levels in soils are also typically not monitored over the long term. At the Pigeon Mine reclamation site, which from casual observation appears to have been extremely well done by the mining company, USGS tests at the site uncovered hot spots that had surfaced since the reclamation effort, demonstrating that there is certainly the possibility of the impacts of radioactivity at mine sites being carried off site in a downstream direction years after reclamation.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Hualapai Tribe-Office of the Chairman	225270	2	Regardless of whether Alternative B is approved, we implore you to: Develop a plan, in consultation with the Hualapai and other affected Indian tribal governments, to mitigate natural, cultural, wildlife and water resource damage from the four existing mines and in advance of the seven potential new mines identified in Alternative B.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Navajo Nation Department of Justice	225264	3	If the U.S. Department of the Interior (USDOI) intends to allow for limited uranium mining and milling for those mining claims where valid existing rights are determined to exist; then the USDOI must be willing to provide adequate resources and technical support to the Navajo Nation for the following: improved emergency planning and response capabilities to address any potential releases of hazardous and radioactive substances along identified transport routes; especially any transport routes that traverse any part of the Navajo Nation; enhanced government-to-government consultation on any subsequent federal decisions that could impact Navajo Nation resources, but not limited to environmental air quality permits, cultural resources determinations, endangered species determinations, and water resources; and enhanced federal policy implementation that supports the role of the Navajo Nation in any subsequent decisions that the State of Arizona may make regarding uranium mining and processing.	The U.S. Department of the Interior (USDOI) is required to consult with the Navajo Nation through the Section 106 Government to Government process on all projects that could impact tribal resources. The Navajo Nation will continue to be consulted on all future BLM and Forest Service mining proposals on a case by case basis using the Section 106 process. The comment request for USDOI to provide resources and technical support is outside the scope of analysis in this EIS.
National Environmental Policy Act				
NEPA: Proposed Action				
Arizona Mining Association	225266	4	Contrary to the stated purpose of the withdrawal, it appears that the proposed withdrawal is merely an effort to restrict mining on public lands. The map of the proposed withdrawal area clearly demonstrates that the proposed boundary extends beyond a buffer zone of the Colorado River and its tributaries to intentionally cover areas of known or expected mineralization.	The proposed withdrawal area, as analyzed in this EIS, is fundamentally the same as that contained in the original petition for withdrawal submitted to the Secretary of the Interior on July 15, 2009. The Federal Register notice of July 21, 2009, the Secretary's Notice of Proposed Withdrawal, contained the boundary which the BLM and Forest Service was required by law (Section 204, Federal Land Policy Management Act of 1976, 43 USC 1714(a); 43 CFR 2310.1) to consider. For more detail concerning the Proposed Withdrawal boundary, see the discussion in EIS Section 1.2.
Arizona Mining Association	225266	6	The Proposed Action is inconsistent with current laws and federal policies. It is unclear why the Secretary of Interior is moving rapidly to block access to one of the largest domestic supplies of fuel necessary to operate new reactors at nuclear power plants being promoted by the Secretary of Energy under President Obama's energy agenda. The Proposed Action also is inconsistent with the Domestic Minerals Program Extension Act of 1953, the Mining & Minerals Policy Act of 1970, the Federal Land Policy and Management Act of 1976, the National Materials and Minerals Policy, Research and Development Act of 1980, and the Arizona Strip Wilderness Protection Act of 1983.	The proposed withdrawal is consistent with all of the Acts cited in the comment. The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and 4.13.
Western	225271	2	The stated purpose of the proposed withdrawal is to protect the Grand	As stated in Section 1.3.1 of the DEIS, the purpose is

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Business Roundtable			Canyon watershed from adverse effects of locatable hard rock mineral exploration and mining for a 20-year period. Yet, this explanation begs many more questions than it answers. Logically, emergency withdrawal implies several things: 1) evidence that environmental degradation is occurring; 2) evidence that the current suite of environmental laws, regulations, agreements, etc. cannot be applied to fix the problems; 3) evidence that the problems are of such scope that emergency withdrawal is the only way to safeguard the resources being impacted. Here, the misapplication is beyond obvious: not only is there a comprehensive set of environmental requirements in place, but there is a good track record of compliance by uranium producers. In fact, the evidence points to the fact that current system of protections -- down to and including specific project reviews -- is working well.	to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the area proposed for withdrawal. The EIS analyzes these potential effects and acknowledges the existing regulations and their effectiveness. The decision to be made is whether or not to withdraw, for up to 20 years, some or all of the area from location and entry based on the analysis in the EIS. The proposed action being analyzed in this document is not an “Emergency Withdrawal” but rather a “conventional” withdrawal pursuant to the Secretary’s general authority in Section 204 of FLPMA.
Western Business Roundtable	225271	4	WITHDRAWAL POLICY MIS-ALIGNED WITH EXECUTIVE ORDER 13563 On January 18, 2011, President Obama issued Executive Order 13563, Improving Regulation and Regulatory Review. The Order directed all federal agencies to develop and submit plans to identify and review existing regulations that can be made more effective and less burdensome, while achieving regulatory objectives.	The NEPA process for the DEIS follows the recommendations issued in this Executive Order.
Western Business Roundtable	225271	5	WITHDRAWAL SHOWS INCOHERENCE OF ADMINISTRATION CLIMATE POLICIES The locking down of access to nearly half the nation’s known uranium reserves is particularly perplexing, coming from an Administration that is clearly committed to implementation with or without Congressional approval of a federal climate policy. We are hard-pressed to see how such a policy can be achieved without a vigorous commitment to nuclear energy and the domestic uranium resources that would fuel the sector.	The purpose and need for this action are described in EIS Section 1.3.1. How a potential withdrawal comports with the President’s Climate Policy may be a factor in the Secretary of Interior’s Decision on Withdrawal, but is not relevant to the EIS analysis.
Northwest Mining Association	225275	2	The stated purpose of the withdrawal would be to protect the Grand Canyon watershed from adverse effects of locatable hardrock mineral exploration and mining for up to a 20-year period. There exists, without the proposed withdrawal, the protections and regulatory tools in place to ensure the Park is protected while allowing the development of critical domestic mineral resources. Existing law, including the Clean Air Act (CAA), the Clean Water Act (CWA), the Endangered Species Act (ESA), the Federal Land Policy and Management Act (FLPMA), the National Environmental Policy Act (NEPA), the National Historic Preservation Act (NHPA), Arizona and Utah environmental laws and regulations, Forest Service (USFS) and Bureau of Land Management surface management regulations and policies, as well as applicable state and local permitting and financial assurance requirements provide sufficient authorities and tools for the protection of all resources while providing for multiple-use of the area. The National Academy of Sciences (NAS) National Research Council (NRC) reviewed the existing federal and state regulatory	As stated in Section 1.3.1 of the DEIS, the purpose is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the area proposed for withdrawal. The DEIS analyzes these potential effects and acknowledges the existing regulations and their effectiveness. The decision to be made is whether or not to withdraw, for up to 20 years, some or all of the area from location and entry based on the analysis in the EIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			framework for hardrock mining and concluded that the existing federal and state laws were generally effective in ensuring environmental protection. Hardrock Mining on Federal Lands, National Academy of Sciences, National Academy Press, 1999, p. 89.	
Northwest Mining Association	225275	5	The proposed withdrawal violates the Mining and Minerals Policy Act of 1970 (MMPA), in which Congress clearly stated that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries, (2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security and environmental needs. For clarification, Congress defined minerals to include all minerals and mineral fuels including...uranium.	The proposed withdrawal is consistent with the Mining and Minerals Policy Act of 1970 (30 USC 21 *et seq.*). Only locatable minerals managed under the Mining Law of 1872 would be affected by this withdrawal action. Furthermore, The Secretary of the Interior retains the authority to approve withdrawals as provided in Section 204 of the Federal Land Policy and Management Act of 1976 (43 USC §§ 1701-1782) and by the rules and regulations contained in 43 CFR 2310.
Northwest Mining Association	225275	10	A mineral withdrawal is an extreme action and should be considered and used only when all other tools have failed to protect the environment and in this case the values of the Grand Canyon National Park and the Colorado River watershed. With respect to the proposed withdrawal, there is no evidence that the other tools in the tool box, such as the performance standards of the 3809 and 228 regulations, have failed to protect the environment and important resources.	As stated in Section 1.3.1 of the DEIS, the purpose is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the area proposed for withdrawal. The DEIS analyzes these potential effects and acknowledges the existing regulations and their effectiveness. The decision to be made is whether or not to withdraw, for up to 20 years, some or all of the area from location and entry based on the analysis in the EIS.
National Mining Association	225281	2	Creation of an additional one million of acres buffer zone around the park is not justified given the lack of evidence in the DEIS that the GCNP is at risk from mining given existing protections. The 1.2 million acres of federal land included in the GCNP are already protected from the impacts of mining as these lands appropriately have been withdrawn from the operation of the Mining Law.	As stated in Section 1.3.1 of the DEIS, the purpose is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the area proposed for withdrawal. The DEIS analyzes these potential effects and acknowledges the existing regulations and their effectiveness. The decision to be made is whether or not to withdraw, for up to 20 years, some or all of the area from location and entry based on the analysis in the EIS.
National Mining Association	225281	4	These laws and regulations that govern mining on federal lands are "cradle to grave," covering virtually every aspect of mining from exploration through mine reclamation and closure. The National Academy of Sciences (NAS) reviewed the existing federal and state regulatory framework for hardrock mining and concluded that the existing laws were "generally	The DEIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable Development Scenarios, Section B.3, Regulatory

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			effective" in ensuring environmental protection. Hardrock Mining on Federal Lands, National Academy of Sciences, National Academy Press, 1999, p.89.	Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place. By law (Section 204, Federal Land Policy Management Act of 1976, 43 USC 1714(a); 43 CFR 2310.1), the Secretary of Interior is required to issue a decision once a valid application for withdrawal has been made.
Quaterra Alaska Inc.	225288	5	The great majority of the mining claims are staked on the belt of mineralized pipes because the mining companies know this is where breccia pipes containing ore bodies are likely to be found. The radical anti-industry groups chose the proposed withdrawal area not because it warrants protection more than other areas, but because that is where the mining claims are. House Rock Valley is included in the proposed withdrawal area, not because there are many mining claims there or because ore bodies are very likely to be found there, but because the Grand Canyon Trust owns a ranch there. The government agencies writing the EIS should be more open and honest about this.	The proposed withdrawal area, as analyzed in this EIS, is fundamentally the same as that contained in the original petition for withdrawal submitted to the Secretary of the Interior on July 15, 2009. The Federal Register notice of July 21, 2009, the Secretary's Notice of Proposed Withdrawal, contained the boundary which the BLM and Forest Service was required by law (Section 204, Federal Land Policy Management Act of 1976, 43 USC 1714(a); 43 CFR 2310.1) to consider. For more detail concerning the Proposed Withdrawal boundary, see the discussion in EIS Section 1.2.
VANE Minerals	242650	1	If one looks at the map of the proposed withdrawal area relative to the density of mining claims, the boundary directly overlays the greatest density of mining claims. The boundary does not follow some thoughtful process such as being located a set distance from the Colorado River or its tributaries or the boundary of a Park or Monument, and even leaves several miles of public land encompassing upper Kanab Creek out of the proposed withdrawal area. There happened to be few or no mining claims in that area at the time the boundary was drawn . One would reason that if the Colorado River and its tributaries are the worry, then the boundary would be drawn reflecting the shape of these features. That indicates that the intent of the proposed withdrawal is on mining claims rather than a set distance to the Colorado River and its tributaries.	The proposed withdrawal area, as analyzed in this EIS, is fundamentally the same as that contained in the original petition for withdrawal submitted to the Secretary of the Interior on July 15, 2009. The Federal Register notice of July 21, 2009, the Secretary's Notice of Proposed Withdrawal, contained the boundary which the BLM and Forest Service was required by law (Section 204, Federal Land Policy Management Act of 1976, 43 USC 1714(a); 43 CFR 2310.1) to consider. For more detail concerning the Proposed Withdrawal boundary, see the discussion in EIS Section 1.2.
Quaterra Resources, Inc.	242664	1	The avowed purpose of the proposed withdrawal is to protect the natural, cultural and social resources of the Grand Canyon watershed from mineral exploration and development. In such a situation, the burden of proof lies squarely with the DOI to show that such activities represent a clear and present danger. The report fails to do this. Ten of the fifteen potential environmental consequences are judged in the DEIS to have no to minimal impact, and three others only minor to moderate impact. Most important, the report describes the impact on the Virgin and Colorado Rivers as negligible. Potential contamination of the Colorado River was the principal trigger for the withdrawal.	Section 1.3 of the FEIS explains the purpose and need of this document. The decision to be made is whether or not to withdraw the area from the Mining Law of 1872, subject to valid existing rights. This EIS is being prepared to help inform that decision.
Frank Bain	242677	4	The issue of the newly proposed area for withdrawal was supposedly settled back in the 1984 when the Arizona Strip Wilderness Act was	The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			passed, an agreement with the USFS, BLM, mining companies, and other interested groups where a large portion of land on the North Rim was withdrawn from mineral entry and that the remaining lands outside of this withdrawal would remain open for exploration and mining. Why is government attempting to renege on this agreement? Why was this agreement and issue not mentioned in the EIS?	4.13.
NEPA: Document Layout				
Energy Fuels Resources	225260	6	I also recommend that the topics under the "Affected Environment" and "Environmental Consequences" should be presented in the same order as in the main body of the DEIS. Changing the order serves no purpose and makes it more difficult to read the document. A summary table could also be added to the "Environmental Consequences" section and in a new 4.17 subsection of the report so that the reader can more easily understand the document's conclusions.	The EIS is presented with the affected environment in Chapter 3 and environmental impacts in Chapter 4. All resources are presented in the same order in both chapters to help the reader easily navigate through the document. A general summary of impacts appears in the Executive Summary and a detailed listing of potential environmental impacts identified as a result of the analysis is provided as Table 2.8-1. The Executive Summary has been modified in the FEIS to present resources in the same order as Chapter 3 and Chapter 4.
Uranium Watch	225262	1	The DEIS lacks citations for most of the data and information in each section. There is just one list of references, rather than references after each section. Therefore, a member of the public has no idea of the source of the data and information in the DEIS.	Each section contains complete references that are then listed in full in Chapter 6, Literature Cited. This chapter is organized alphabetically in order to help the reader find the appropriate reference. There is no requirement that references appear at the end of each section.
Uranium Watch	225262	5	The DEIS contains extensive references. However, there is no indication of where the referenced material is available to the public. The agencies must make all referenced documents publicly available by providing a link to those documents on the EIS website.	References are documented in the project file. Cited references must be either generally available to the public (such as on the internet or a public library) or available upon request. There is no requirement that referenced materials be made available via the BLM project website.
Ted Jensen	225282	13	Executive summary includes a statement of purpose for each of the different study categories and then later restates the categories with study results. The executive summary document length can be cut in half by just combining these sections. For example, Air Quality concerns (pg. ES-2) portion should be combined with Impacts on Air Quality (pg. ES-13). Also, by stating the concerns without the details can be very misleading. It is misleading to allow for unsupported statements to be made and then add clarifications or ratings later	The issues and concerns described in the first part of the Executive Summary are those that were identified as a result of the public scoping process for this project. The impacts summarized later in the Executive Summary are those identified as a result of the EIS analysis (i.e., they summarize the results detailed in Chapter 4, Environmental Consequences).
Ted Jensen	225282	14	The Introduction section should simply state it is the Introduction. On page 1-1 it states the introduction as follows: Introduction: Purpose Of And Need	There is no bias inherent in the title of this chapter. It serves as both an introduction to the EIS and identifies

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			For Action. This is not an unbiased statement and implies closure.	the purpose of and need for action, which is a NEPA requirement (40 CFR 1502.13)
Ted Jensen	225282	17	The initial basis for the closure was the downstream water quality concerns. The open forums led by Representative Grijalva clearly expressed this as a primary concern. On the last page it states that impacts on the Colorado water is none to negligible. This is a major component of the study and deserves much emphasis or additional weight, yet, this critical study result is all but buried on the last page.	Numerous issues and concerns, from federal, state, and municipal agencies as well as tribes and members of the public, were identified during the scoping process for this EIS. They were not limited to water quality concerns. The issues identified for further analysis are discussed in Chapter 1, Section 1.5. The purpose and need for the proposed withdrawal is described in full in Chapter 1, Section 1.3.
Quaterra Alaska Inc.	225288	6	There are many examples of failing to provide perspective in the DEIS, where numbers are quoted without giving anything to compare them to. For example quoting the total amount of gaseous emissions from all the projected mines over a 20 year period gives some large numbers until they are compared to automobile emissions, non-road equipment emissions, forest fire emissions, and others in table 3.2-5. Many numbers for emissions are included in the EIS, but they are in widely separated sections so that they cannot easily be compared.	The data provided in Chapter 3.2.3 *Existing Air Quality*, Tables 3.2-4 and 3.2-5 were not intended for comparison of one source to another. These data are used for modeling purposes and provide the basis for existing (i.e., background) air quality.
Quaterra Alaska Inc.	225288	10	p.4-13 Table 4.2.4 Incomplete labeling It appears that the numbers in the table are not completely defined. Are they tons per day, tons per month, tons per year etc?	It is unclear as to which table the commenter is referring, but it is believed the commenter is referring to Table 4.2-4, *Hypothetical/Typical Mine Vehicle/Equipment Exhaust Emissions in Tons* (DEIS page 4-13). The units of Table 4.2-5 should be expressed in tons per mine life. The units in Table 4.2-5 have been revised.
Lela Rhodes	226422	2	While reviewing your maps of surface ownership, I find no indication of private land in House Rock Valley. It should be widely known that the Kane and Two-Mile Ranches now belong to the Grand Canyon Trust. Though they are a so-called nonprofit organization, their ownership of those lands are considered Private and should be noted in that manner on your maps.	Surface ownership as shown in the DEIS is accurate.
Lela Rhodes	226422	6	With the number of errors in this document, it seems that it would be more appropriate to re-issue a DEIS that has been reviewed for accuracy and one that actually states a preferred alternative as NEPA requires.	BLM recognizes there are a number of typographical and other errors in the DEIS. These have been corrected for the FEIS. Department of the Interior NEPA Implementing Regulations, at 43 CFR 46.426(a), state: "Unless another law prohibits the expression of a preference, the draft environmental impact statement should identify the bureau's preferred alternative, if one or more exists." No preferred alternative existed at the time the Draft EIS was published. Both the Department of Interior Office of Environmental Policy and Compliance and the USDOI solicitor's office

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				approved the Draft EIS publication without a Preferred Alternative. Agencies frequently refrain from identifying a preferred alternative in the DEIS, both so as to avoid the appearance of a final decision having been made prior to the DEIS even being published, and because they wish to elicit as much input from the public and other interested parties prior to actually deciding what their preferred alternative will be. See Question 4c, Council on Environmental Quality's Forty Most Asked Questions Concerning CEQ's NEPA Regulations.
NEPA: Review Timeline				
The NAU Project, LLC	254	1	The NEPA rules indicate that the DEIS be as compact as possible and not to run too much over 300 pages. This EIS is way beyond this and 45 days to review and comment is scarcely enough time to do this.	The review time for the DEIS was extended from 45 days to 75 days to allow additional time to review and provide comments. Although the EIS exceeds the number of pages suggested by CEQ regulations, it contains the number of pages needed to provide the information necessary to inform the Secretary of Interior's decision.
Quaterra Alaska Inc.	39195	1	I have concluded that the 45 days allotted for public response is far too short a time a minimum of 90 days, and more if possible, are needed for an objective and fair response.	The review time for the DEIS was extended from 45 days to 75 days to allow additional time to review and provide comments.
Patrick Hillard	50520	1	After extensive review of the document I have concluded that the 45 days allotted for public response is far too short a time, giving the impression that the Federal Government is attempting to "cram it down the throats" of the public. There is significant material presented in the draft with which I and other people knowledgeable about the withdrawal area disagree, however a reasonable amount of time is required for research to document and provide details concerning our facts.	The review time for the DEIS was extended from 45 days to 75 days to allow additional time to review and provide comments.
Sedona Chamber of Commerce	50524	2	We understand that your two-year temporary ban will expire on July 20, 2011, and that exploratory drilling on thousands of new claims would immediately resume. We urge you to complete the environmental review process and issue a decision well before that deadline.	An Emergency Withdrawal was issued by Secretary Salazar that expires January 20, 2012, to allow for the completion of the FEIS and final decision.
Arizona House of Representatives	54290	3	I support Alternative B and strongly encourage you to make a final decision prior to July 20, 2011, when the current segregation order expires.	An Emergency Withdrawal was issued by Secretary Salazar that expires January 20, 2012, to allow for the completion of the FEIS and final decision.
Grand Canyon Wildlands Council	97142	1	The AZ Strip website (http://www.blm.gov/az/st/en/prog/mining/timeout.html) states that the DEIS for the Uranium Mineral withdrawal is scheduled for release in "early 2011." Do you have an updated timeline for this process?	The final EIS is scheduled to be released to the public in the Fall of 2011. The decision by the Secretary of Interior can be issued as soon as 30 days after that.
AZ State Senate	213915	3	It is imperative that action be taken on this proposal prior to the expiration	An Emergency Withdrawal was issued by Secretary

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			of the current segregation order (July 20, 2011) so the area remains closed to mining.	Salazar that expires January 20, 2012, to allow for the completion of the FEIS and final decision.
Energy Fuels Resources	213922	1	I have been reviewing the EIS and I intend to provide substantive comments. However, the current 45-day comment period for such a massive document that exceeds 1000 pages and took over 1 1/2 years to prepare is insufficient. The ability to review and analyze the draft EIS is crucial for me to provide meaningful comments that need to be considered before any final decision is made with respect to the proposed withdrawal. Therefore, I request an extension of the comment period for an additional 45 days from the current April 4 deadline.	The review time for the DEIS was extended from 45 days to 75 days to allow additional time to review and provide comments.
National Mining Association	213923	1	NMA intends to provide substantive comments on the draft EIS. However, the current 45-day comment period for a document that exceeds 1000 pages is simply insufficient. The ability to review and analyze the draft EIS is crucial to NMA's effort to provide meaningful comments that need to be considered before any final decision is made with respect to the proposed withdrawal. Therefore, NMA requests and extension of the comment period for an additional 45 days from the current April 4 deadline.	The review time for the DEIS was extended from 45 days to 75 days to allow additional time to review and provide comments.
Northwest Mining Association	213924	1	The Northwest Mining Association (NWMA) hereby requests a 45-day extension to the public comment period for the Draft Northern Arizona Proposed Withdrawal Environmental Impact Statement (EIS). On Feb. 18, the Bureau of Land Management (BLM) announced the opening of a 45-day public comment period on the Draft EIS, set to expire on April 4. A 45-day comment period is insufficient to adequately analyze and provide meaningful comments on a document of more than 1,000 pages.	The review time for the DEIS was extended from 45 days to 75 days to allow additional time to review and provide comments.
Frank Bain	242677	2	The comment period needs to be extended again, new public meetings scheduled, and anyone with a comment, pro or con should be allowed to speak.	The review time for the DEIS was extended from 45 days to 75 days to allow additional time to review and provide comments. During the public comment period, public meetings were held in Phoenix, Flagstaff, and Fredonia Arizona, and in Salt Lake City, Utah. At each of these meetings attendees were allowed to write a question on a card that was read and answered for everyone at the meeting. Attendees were also given the opportunity to meet individually with agency and contract resource specialists.
NEPA: Purpose and Need				
American Clean Energy Resources Trust (ACERT)	225256	7	PURPOSE AND NEED Page ES-1 to 2 Statement: *The need for the preparation of the EIS has been established by three factors: the Secretary's proposed withdrawal, the lasting impacts of some of the historic hard rock mining activities in the Grand Canyon watershed, and the concern that these historical impacts and the recent increase in the number and extent of mining claims in the area could have adverse effects*	The legacy of impacts created by uranium mining and processing in the region extends well beyond the Orphan mine. The DEIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			on resources within the human environment Comment: This statement is deceitful. First, the Secretary's proposed withdrawal is purely politically motivated and brought about by pressures from special interest groups. Second, to address the "lasting impacts of historic hardrock mining activities in the Grand Canyon" area can only be a veiled reference to the Orphan Mine which began as a claim filed in 1893 - before the Grand Canyon was made a National Park - and started copper production shortly after the turn of the century. Uranium was eventually discovered in the ore and mined there from 1953 to 1969 - long before current mining laws, permitting, rules, regulations and mining practices were in force. All mining in the area dating from the 1980s to the present day have followed the myriad of stringent federal and state laws, rules and regulations beyond the letter of the law, all the way to its very spirit. Energy Fuels Nuclear (a company which mined uranium on the Arizona Strip throughout the 1980s) volunteered to completely reclaim the Orphan Mine at no charge to the government eliminating and removing any and all radioactive contaminates and permanently sealing all shafts, edits and other access to the mine. This offer was rejected by the National Park service! To continue to use the Orphan Mine as the poster child for bad mining practices is inappropriate and misleading. If this is a reference to old mines on the Navajo Reservation, you are referring to basically ancient times in mining history. Those mines were active at a time when the Atomic Energy Commission (AEC) (one of your fellow agencies) was actively encouraging uranium mining. The AEC was not concerned with possible health issues, nor were prospectors or miners at that time. If the AEC had knowledge of the mining hazards, they did not share the knowledge that miners were at serious risk of illness. The resulting abandoned mines were under the supervision of one of your agencies so to blame industry is truly unbelievable! Third, to equate any number of mining claims with an actual operating mine, and then, to further, equate any future mine with the impacts caused by historic mines such as the Orphan is simply disingenuous and demonstrates the bias that is rife throughout the DEIS. Fourth, the preparers of this document did not research the number of claims that were active during the strong mining activity in the 1980s. For your information: **(SEE COMMENT #225256 for detailed table information)** As you can see, there were far more claims in the 80s with active exploration and mining. The immense weakness of this report is that there are extremely limited references to the exemplary mining activities that took place in this area during the 80s and early 90s	Development Scenarios, Section B.3, Regulatory Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
Doug Regan	242175	1	In a time of rising concern for the energy needs of the nation and the world, nuclear energy must remain an option. However, cleaner, cheaper, and safer options are available that have not been sufficiently exploited. Ample sources of uranium have already identified in areas where exploitation does not incur the types and severity of impacts associated with hardrock mining in the rapidly dwindling areas of fragile arid lands of	The purpose and need for the proposed action is defined in Chapter 1, Section 1.3. The overall objective of this EIS is to allow an informed decision to be made as to whether or not to withdraw lands in the area from locatable mineral exploration and development.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the Southwest. Such considerations are part of the overall evaluation of the PURPOSE AND NEED for allowing mining permits in the Arizona Strip. Such a need AT THIS TIME has NOT been demonstrated.	
NEPA: General Impact Analysis				
Quaterra Alaska Inc., Patrick Hillard	39195, 50520	2	Some of the government agencies (not the BLM) which have contributed to the draft have been openly opposed to mining for many years. I cannot believe that their conclusions and presentation of data are as objective as they would be if these agencies were neutral. Some of these same agencies in the past have accepted data and information from the radical anti-development groups including but not limited to the Grand Canyon Trust, the Sierra Club, and the Center for Biological Diversity. Many of the people from these groups who have provided information have no professional credentials and have been known to make up facts to suit their own purposes. Thus even more time is required to counter prejudiced conclusions and bad information.	No data or analyses from any special interest groups were used in development of the EIS. The commenter is referred to Chapter 6, Literature Cited, to review the source materials that did contribute to the analysis.
Valarie Bryant	50529	1	In reading through the Executive Summary and Table 2.8-1 Summary of Potential Environmental Impacts by Alternative, it seems, even though the entire study was very well prepared, that this is still a "best guess" scenario. Almost all the impact statements contain the phrase; 1) are not able to be determined, 2) if any impact would occur, 3) impacts could range from, 4) changes might be large, 5) impacts on ___ are possible or vary, depending on, 6) may impact, 7) would depend on, 8)assuming that, 9) could result, 10) depend on. You are, therefore, saying that you just do not know!	The DEIS was prepared using the best peer-reviewed scientific studies available. But, even so, there are known to be gaps in the data and other some information is largely non-existent at this time. Incomplete or unavailable information is identified in each Chapter 4 resource section. The DEIS does, however, provide adequate data to distinguish between the alternatives and to make an informed decision (see 40 CFR 1502.22).
Valarie Bryant	50529	2	How about presenting known facts on mining effects. The USGS Fact Sheet 2010/3050 "Breccia Pipe Uranium Mining etc" seems to support this negative effect-under the "effects of 1980's uranium mining" paragraph.	Much of the analysis presented in the EIS is based on the USGS studies specifically cited in USGS Fact Sheet 2010-3050.
Arizona House of Representatives	54290	2	I am also concerned about failures to enforce much-needed safeguards to prevent pollution from mining. In 2009, a Canadian mining company reopened a uranium mine located on the Arizona Strip District of the Bureau of Land Management. The company is routinely found to be operating in violation of state and federal regulations. While Arizona's Department of Environmental Quality has some regulatory authority it is unable to monitor the mine's operations to protect air and water quality.	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.
Alan Kuhn	87261	2	The methodology and conclusions in this DEIS are flawed. The DEIS ignores the fact that modern exploration, mining, and reclamation techniques are protective of the environment when applied properly, and the actual footprint of uranium or other mineral development in the subject	The DEIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			area is very small and quite manageable with modern methods.	Development Scenarios, Section B.3, Regulatory Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
Mari Rubens	104124	1	In regards to the Flagstaff public meeting: Why could the Havasupai people not receive an answer regarding impact to animals & flora from levels other than federal that was very limited?	Potential impacts to flora and fauna under each alternative are described in Sections 4.6, 4.7., and 4.8 of the EIS. In addition to species listed or candidates for listing under the federal Endangered Species Act, the impacts analysis discloses anticipated effects on BLM-listed Sensitive species, Forest Service-listed Sensitive species, National Park Service-listed Species of Concern, and Arizona State Game and Fish Department-identified Species of Greatest Conservation Need.
Cynthia Pardo	104125	5	Please assess the impact if an accident from uranium mining were to occur. - This is not, and should not, be out of the purview of the study.	Assuming the commenter is referring to potential accidents involving haul trucks coming to/from any mines, this issue is addressed for each of the alternatives in Chapter 4, Section 4.15, Social Conditions, under the subheading "Transportation Conflicts." Historical contamination of Navajo lands by mining activities in the 1940s—1970s is discussed in Chapter 3, Section 3.15, under the subheading “Withdrawal Support,” and known health risks are described in the pages immediately following under “Public Health and Safety.”
Darrin Kaska	104134	1	I see that only forest and National Park service has been inspected, why not the state land be included too?	Withdrawal alternatives analyzed in the EIS are only applicable to minerals under federal (e.g., BLM, Forest Service) jurisdiction. The Secretary of the Interior does not have authority to withdraw minerals not under federal jurisdiction.
Dawn Dyer	104170	1	I believe the DEIS does not adequately stress the fragility and importance of the area surrounding the Grand Canyon to local residents, native tribes, water safety, biodiversity, and local economies.	These resources are each addressed in detail in Chapters 3 and 4. See the sections on Social Conditions, Water Resources, Vegetation Resources, Fish and Wildlife, Special Status Species, and Economic Conditions, respectively.
Kristen Wert	213916	1	The work "compliance" shows up in the EIS document a total of 38 times. The word "non-compliance" shows up zero times. So I'm guessing company non-compliance with environmental regulations was not included as a worst case scenario in the environmental and economic impact estimates for the alternative scenarios. You are assuming that mining corporations would comply with all environmental regulations. But we've already seen the Denison re-opened the Arizona 1 mine without approval	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			from the EPA (see Denison attachment). Wouldn't this company also be the one most likely to develop other mining sites in the area? This company's refusal to comply with laws is not an isolated case. There are other examples of uranium mining companies failing to follow federal and local regulations. (For example see the Crow Butte attachment.) Even if regulations were enough to prevent severe damage to the environment, there is no guarantee that it would not be more profitable for mining companies to violate laws and pay the resulting fines than it would be for them to follow regulations in the first place.	NEPA does not require development of worst-case scenario. The worst-case analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618 (Apr. 25, 1986). CEQ Regulations require analysis of reasonably foreseeable impacts, not worst-case scenarios. Nevertheless, in an effort to address this concern, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to agreement as to how to best coordinate their future monitoring and enforcement efforts in and around Grand Canyon National Park.
Kanab Utah	225250	2	The EIS substantively ignored requirements of Section 1502.16 (c) which requires discussions of possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (and in the case of a reservation, Indian tribe) land use plans, policies and controls for the area concerned.	Subsection 1.4.4 has been added to Chapter 1 to address conformance of each alternative with existing federal, county, tribal, and municipal land use plans.
Donald Begalke	225254	2 & 3	On Page ES-2 in the paragraph on "Public Issues and Management Concerns Identified During Scoping", the sentence *All comments received for this scoping effort were assigned, based on content, to one of nine preliminary concerns' categories*. What were the 9 categories? Why are those 9 categories not immediately printed in this Draft? Why does this Draft lack accountability on the preliminary concerns' categories? "Individual comments were then assigned to one of 25 resource categories on the basis of the overall theme of the comment" informs. The resource categories are immediately printed beginning with "Air Quality" on Page ES-2, continuing to ES-3 and ES-4 through "Wildlife", each with a general definition (?). What is not included with the printing of the resource classifications are the scoping impacts of each category! The reader receives no scoping impact for any of the "25" as he/she is headed toward the Draft's sections on "Affected Environment" and "Environmental Consequences". How many of the scoping statements were assigned to "Air Quality"? To "Alternatives"? To "Cultural and American Indian Resources"? To "Aquatic Wildlife"? To "Cumulative Impacts"? To "Economic Conditions and Values"? To "Environmental Justice"? To "Healthy and Safety"? To "Lands"? To "Laws and Policies"? To "Minerals"? To "Miscellaneous"? To "Natural Environment"? To "Noise"? To "Persons and Groups Affected"? To "Recreation?" To "Social Conditions and Values"? To "Species of Concern"? To "Soils and Geology"? To "Transportation"? To "Vegetation"? To "Visual Resources"? To "Water Resources"? And to "Wildlife"? The assignments' total numbers for all 25 resource categories would accountably be 83,525, but the	The Executive Summary has been revised to explicitly state that a separate, 98-page Scoping Report was produced in March 2010 and made publicly available on the BLM project website.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			specific numbers are flagrantly missing -? For best assessments of the categories, having each broken down into sub-categories would show project accountability, and I request BLM do the breakdowns for the Final EIS. Realities inform that thousands of scoping commentors have been unjustly wronged by this Draft's "*Individual comments were then assigned to one of 25 resource categories on the basis of the overall theme of the comment".* Some verbal scoping presentations would have multi themes, and are missing -?	
Donald Begalke	225254		Continued... Businesses may have presented scoping comments on lands, minerals, transportation and health/safety issues; yet no discussions are included for those four (possible) business categories. If an organization's scoping letter included statements about archaeological resources, vegetations and water; are their three concerns identified in 3 categories? Thus, for each example, the true assignments' accountabilities would respectively be in "multi categories", four categories and three categories. To report less or to not report "all" distorts the validity of the scoping process. I respectfully request the BLM Arizona Strip District Office to numerically provide the correct scoping comments' numbers per resource category by the singular theme and by presentations/letters having multiple themes. As a result the reader/assessor will have an understanding of the true-concerns' totals, which collectively will number in the hundreds of thousands of single-themed scoping comments greater than 83,525. since scoping comments were submitted by U.S. Citizens/Businesses/Organizations, and also by peoples/businesses/ organizations from countries around our Earth, should not this Draft include resource category numbers by the V.S. submissions and by other-countries' submissions, and by individual, family, business and organization totals, too? Possibly cross-countings would also help the reader assess the scoping process for this project. For the Final EIS, I requests BLM's improvements on this Draft. In this Draft's "Affected Environment" section (Pages ES-8, -9, -10, -11, -12), why are only 15 subsection categories explained compared to 25 resource categories? Is "consistency" a difficulty in this project? What details were not completed? Resource categories not explained as "Affected Environment" subsections are: Alternatives, Cumulative Impacts, Environmental Justice, Health and Safety, Lands, Laws and Policies, Miscellaneous, Natural Environment, Natural Resources, Persons and Groups Affected, and Transportation. The list of resource categories in the previous sentence requires explanations for the Affected Environment to be completely presented. Yet, "Wilderness" is a subsection of Affected Environment, but not a subsection of the resource categories. The same inquiries apply to the "Environmental Consequences" (Pages ES-13, -14, -15, -16, -17). The omitted resource categories need to be presented in Environmental Consequences. Wilderness is presented in the E.C.s, but not in resource categories. Confusions abound for the reader of this Draft and for full	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			presentations.	
Donald Begalke	225254	6	Further, BLM should insert another map or maps in this Draft demonstrating all the additional locations of the *"thousands of new mining claims to be located in the area*" along with the existing uranium mining claims.	Since the publication of the proposed withdrawal in the Federal Register on July 21, 2009, no new mining claims have been located in the area. Current mining claim information is available on the BLM's LR2000 system (http://www.blm.gov/lr2000/). The Mining Claim Recordation (MC) section contains information on unpatented mining claims located on federal lands within the area proposed for withdrawal
American Clean Energy Resources Trust (ACERT)	225256	4	READER LETTER Statement: *The planning area consists of approximately 1,010,776 acres of federal mineral estate, which includes about 626,354 acres of public lands managed by the Arizona Strip Field Office, 360,349 acres of National Forest System lands managed by the Kaibab National Forest, 4,284 acres administered by the Arizona State Land Department, and 19,789 acres of private land.* Comment These numbers are consistent with Table 6 in the Executive Summary; however, they are inconsistent with the numbers in the text prior to Table 6. Please correct the text or the table, whichever contains the incorrect numbers	All acreage calculations have been reviewed and corrected as necessary in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	5	Page ES-1 Statement: *Currently, approximately 1,010,776 acres of federal mineral estate are segregated from entry under the Mining Law and are divided into three parcels. The three proposed withdrawal parcels border Grand Canyon National Park. They are all rich in natural and cultural resources and are intricately connected to the watershed of the Grand Canyon. The North Parcel comprises approximately 554,124 acres, the South Parcel approximately 134,454 acres, and the East Parcel approximately 322,198. Approximately 27,775 acres of non-federal surface are located within the three segregated parcels.* Comment: (1) An approximate number of acres seem inadequate for a thorough and long lasting withdrawal proposal such as this DEIS encompasses. (2) Upon review of the table on ES-6 it appears that your statement above has an error about the number of acres in the South and in the East. The table indicates that the South parcel has 322,198 acres and the East parcel has 134,454 acres. Which numbers are correct? The above text indicates that nonfederal surface acreage is 27,775, yet the table clearly indicates that the surface ownership of non-federal lands is 19,789. Which number is correct? Please correct the incorrect information so the reader has consistent numbers to evaluate.	All acreage calculations have been reviewed and corrected as necessary in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	6	Page ES-2 Statement: *Neither the current segregation order nor the proposed withdrawal apply to non-federal mineral estate or to leasable or salable minerals (e.g., oil and gas leasing, sand and gravel permits), which are not subject to appropriation under the Mining Law.* Comment: It appears to be inconsistent and discriminatory to allow other mining and drilling on the lands in the withdrawal area. Those processes would also	As stated in the July 21, 2009 Federal Register notice announcing the segregation and proposed withdrawal, "The purpose of the withdrawal...would be to protect the Grand Canyon watershed from adverse effects of *locatable hardrock mineral exploration and mining"* [emphasis added]. Leasable and salable mineral

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			impact the soil, view, air, wildlife, birds, plants, water, traffic and every other issue raised in this DEIS.	exploration and development were not included in the Secretary's proposal and are thus beyond the scope of this EIS.
American Clean Energy Resources Trust (ACERT)	225256	8	Page ES-2 Statement: *By the end of the scoping period, the BLM had received 83,525 comment submittals. All comments received for this scoping effort were assigned, based on content, to one of nine preliminary concerns categories. Individual comments were then assigned to one of 25 resource categories on the basis of the overall theme of the comment Comments were received concerning the proposed withdrawal as well as concerning exploration and development activity.* Comment: It is curious to note that the total number of transmittals from the scoping process was used in this executive summary when, in fact, the Scoping Report states that 1,805 of these comments were identified as duplicate submittals. "Of the 81,720 non-duplicate submittals received, 93.55% (76,452) were identified as form letters, 5.72% (4,671 submittals) as form letters with additional comments, .03% (28) submittals as public comment forms and the remainder as original content submitted via email (0.52% or 428), letter (0.17% or 139) or fax «0.01% or 2)," When questioned about the validity of the email submittals, the BLM could not confirm that each submission was a unique, identifiable individual submission. Yet the comments were tallied (as you would in a vote) and used as the basis for this DEIS. The highly questionable number of comment submittals (782) coming from Tucson, Arizona, home of Center for Biological Diversity Board Member and Congressman Raul Grijalva, creates further doubt about the validity of the comment submittals received. Review of the categories created by the scoping comments suggests that particular comment exercise was, in fact, a vote. The uranium resources in northern Arizona are far too important to the region and the nation to allow a "beauty contest" vote to determine the issues or the outcome	As stated in 40 CFR 1501.7 and in BLM NEPA Handbook H-1790-1, the fundamental purpose of scoping is to help identify potential issues, impacts, and alternatives to be analyzed in detail in the EIS, as well as those that are probably not significant enough to warrant detailed analysis. Scoping is typically conducted internally (among agency staff) and externally interested government agencies, non-governmental organizations, industries, and the public in general. It is not a balloting process, but a means to help assure that all issues relevant to the EIS are adequately investigated. Public scoping comments are tallied for statistical purposes and as a matter of public record.
American Clean Energy Resources Trust (ACERT)	225256	9	LANDS ES-3 Statement: *The proposed withdrawal area includes 986,703 acres of federal locatable minerals underlying public (BLM) land and National Forest System lands and 24,073 acres of federal locatable minerals underlying non-federal surface.* Comment: In this section it is stated without estimation that "the proposed withdrawal area includes 986,703 acres of federal locatable minerals underlying public (BLM) land and National Forest System lands and 24,073 acres of federal locatable minerals underlying non-federal surface." Yet later in the DEIS the number changes from a definite number of acres to an "estimated" number of acres. It seems that the acreage should be absolute number to even begin to develop an EIS.	The area under review is remote and undeveloped. While cadastral survey has been conducted to establish land locations, the lack of survey associated with aspects of this analysis dictate that the acreage calculations used are estimates derived from GIS or other techniques. All acreage calculations have been reviewed and corrected as necessary in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	10	ES-4 Statement: *Groups affected by the proposed withdrawal include the BLM, U.S. Forest Service (Forest Service), National Park Service (NPS), and U.S. Environmental Protection Agency (EPA); state, local, and tribal governments; business and industrial organizations; and environmental*	The commenter appears to be reading more into the reference to the Center for Biological Diversity (CBD) than the EIS authors intended; the CBD was only cited as an example of an environmental NGO because the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			groups such as the Center for Biological Diversity. Persons affected include local citizens, including tribal members, the touring and recreating public users, and citizens both national and international. Comment: You have chosen an interesting example in the Center for Biological Diversity (CBD) as an environmental group. The instigator for this withdrawal is Raul Grijalva, CBD Board Member and Arizona Congressman. By listing the organization's name, it gives the perception of collusion rather than a good example of a concerned "environmental" group. And, when you review the CBD website, it would appear they are more of a law firm than an organization concerned with the environment. This is another example of a biased report. You have also mentioned international citizens as people affected by the possibility of mining in northern Arizona. Are you suggesting that the occasional international visitor to the Grand Canyon is going to be adversely affected by mining in any of the areas proposed as withdrawal areas? International visitors to this country consider this nation to be one of the most wasteful in the world. And if queried about this issue would most likely comment that it is a tremendous waste of our domestic resources.	CBD has, along with the Sierra Club, the Grand Canyon Trust, and others, been highly active in attending scoping and other public meetings on the project and in submitting comments throughout the process. Their comments, however, receive no greater or lesser degree of consideration than those submitted by anyone else. This reference to the CBD has been removed in the Executive Summary of the FEIS. Since the area does receive international visitors, and especially the Grand Canyon, they do comprise a component of the public demographic that could be potentially affected by the action. We received, and accepted, comments from people all over the world.
American Clean Energy Resources Trust (ACERT)	225256	15	1.2 BACKGROUND Page 1-3: Reasons for the EIS Comment: The public needs to know that the withdrawal came about because of pressure from the radical anti-industry groups such as the Grand Canyon Trust, Center for Biological Diversity, and Sierra Club, and that the BLM and Forest Service did not on their own decide that a withdrawal should be considered. The public also needs to know how many tax dollars have been and will be spent on the withdrawal, the EIS, and associated activities. The public also needs to know that no matter how much "science" is involved in the EIS the decision on the withdrawal will be political rather than objective.	The purpose of and the need for the Proposed Action are documented in Chapter 1, Section 1.3.
American Clean Energy Resources Trust (ACERT)	225256	16	Page 1-4 Statement: *The 2-year segregation does not prohibit continuation of already approved mineral exploration and development activity, nor does it prohibit the approval of new mining on existing mining claims, provided that those claims were valid as of July 21, 2009, and have remained valid. As of June 2010, there were approximately 5,300 mining claims located within the three segregation parcels.* Comment: According to the BLM Database, in 2010 there were 5,207 claims in the three segregation parcels. For your information, each claim requires an annual $140 renewal rental fee (they are likely to be renewals as no claims would be staked under the segregation). Those claim fees provided the BLM with $728,980 in income in 2010 while the claimants were not able to utilize the land. Let's just say if the number of claims remained the same for 20 years and the annual renewal rate remained the same, the loss to the BLM and thus the federal government would be $14,579,600. If the land is withdrawn, it can be assumed that those claims will be released and that loss will become a reality. If there is no withdrawal and additional claims	The annual fee noted is cost recovery of BLM expenses incurred in administering claims, so a reduced number of claims would result in corresponding reduction in BLM expenditures. The annual mining claim maintenance fee assists in covering the costs that BLM incurs in the mining law administration program.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			could be filed and we could assume (assuming is consistent with this DEIS) that the number increases to the same number of active claims in 1988 which was 23,929, the annual income to the BLM would be $3,350,060. That would be a great addition to the BLM coffers. And, if that number of claims remained consistent throughout the next 20 years, the income would be $67,001,200. Imagine losing that income to satisfy a political maneuver. It is irresponsible and lacks fiduciary accountability.	
American Clean Energy Resources Trust (ACERT)	225256	17	Page 1-4: Impacts of past mining activities Comment: The EIS says that past mining activities have left lasting impacts. There were no requirements for reclamation when these historic projects were terminated; if there had been these projects would be unnoticeable today. Under present regulations, mining sites must be fully reclaimed and a bond covering the full cost of reclamation must be posted. The bond is not returned until the appropriate government agency has approved the reclamation. If the party posting the bond does not perform the reclamation, the bond is forfeited and a contractor is hired to do the reclamation. The EIS should mention that at the time these historic mining activities were carried out there were no requirements for reclamation. It should also mention that today reclamation is required by law, and that a bond must be posted.	Although current reclamation bond requirements are discussed in EIS Appendix B, Section B.3.4, Plan of Operations Approval Process, the FEIS has been revised in Section 3.5.4 to reflect the distinction between current requirements and historic practices.
American Clean Energy Resources Trust (ACERT)	225256	19	Pages 1-10 through 1-18 Statement: *A number of legal authorities apply to the processing of the proposed withdrawal application and preparation of the associated EIS. These include laws, policies, and orders that established the basic tenets of the Mining law, set the requirements for consultation between federal agencies and tribal governments, formulated the policies on the use of federal lands, promulgated the regulations for mining on federal lands, and set overall management objectives in agency legislation.* Comment: It is almost inconceivable that the architects of this DEIS would omit Public Law 98- 406 (the Arizona Strip Wilderness Act) from the list of legal authorities. When passed and signed into law in 1984, the Arizona Strip Wilderness Act was thought to have once and for all addressed any and all questions of wilderness and conservation in northern Arizona. The Arizona Wilderness Act specifically recognized the uranium potential of over one half million acres of Bureau of land Management (BLM) and U.S. Forest Service lands in northern Arizona by releasing them from wilderness classification so they could be explored and mined. With overwhelmingly strong bipartisan support from all factions across the entire political spectrum of the time, Congress spoke and clearly defined the disposition of public lands in northern Arizona. Most believed that the years of controversy and debate, as well as the uncertainty and constant reevaluation, were over. However, it would appear that (with this DEIS) the wheel is again being reinvented. The omission of Public law 98-406 (Arizona Strip Wilderness Act) is clearly prejudicial against the uranium mining industry.	The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and 4.13.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
American Clean Energy Resources Trust (ACERT)	225256	21	Page 2-33, Table 2.8-1 Statement: *Under Alternative A, the mines would produce 33,155 tons of URANIUM (U30 S), over a 20-year period. Under Alternative B, this would be reduced to 4,147 tons.* Comment: This is a reduction of 29,008 tons. What is the rationale to deprive the local economy of the benefits of 87.5% of the mineral? It is recognized that these values are computed on a different basis. However, the net result shows that 11 mines would produce only 4.147 tons of U30 e and the other 19 would produce 29,008 tons. By presenting the material in this manner, there is a bias towards emphasizing that the production when there is withdrawal (Alternative B) is considerably less than when mining is allowed (under Alternative A). Should an EIS present the data in such a manner and claim to be objective?	The section of Table 2.8-1 cited in the comment presents the availability of mineral resources data that resulted from the analysis. Review of the assumptions used to estimate the uranium production figures under each alternative have resulted in a change to uranium production figures. The revised numbers can be found in Table 2.8-1, Chapter 3 Section 3.3.1, and Chapter 4 Section 4.3.4.
American Clean Energy Resources Trust (ACERT)	225256	119	Page 5-1, 5-2 Statement: *Members of the public were afforded several methods for providing comments during the scoping period. These included multiple comment stations with comment forms at the scoping meeting and the opportunity to send emails or letters to BLM personnel. A total of 83,525 individuals submitted comments.* Comment: Again it bears repeating, the DEIS continues to use the number 83,525 individuals submitted comments. (1) In reality and in print below there were actually 81,720 comments submitted. (2) Your statement that 83,525 individuals submitted comments does not match Table 6 below (from the Scoping Report). This comment is written to once again illustrate the discrepancy in the numbers you use in this report. It also highlights the misuse of certain wording that would mislead the reader. (3) There is no verification that 81,720 UNIQUE senders wrote letters and/or sent emails to the BLM.	Scoping Report Section 4.0, "Summary of Public Scoping Comments," documents the overall numbers and statistical breakdown by type of public comment received. The commenter is correct in stating that 83,525 individual comment submittals were received, but that 1,805 of these were identified as duplicate submittals. The language in Section 5.1 of the FEIS has been revised to be consistent with the Scoping Report.
American Clean Energy Resources Trust (ACERT)	225256	120	Page 5-2 Statement: *The second newsletter, to be published in September 2010, will announce the public availability of the Draft EIS and include information on the alternative development process, maps illustrating the alternatives, and a narrative discussion of each alternative.* Comment: The Draft Environmental Impact Statement was presented to the public on February 18, 2011. To include a statement that gives a "future date of September 2010, demonstrates the lack of quality review that this give to report. Either change the date for publication of the second newsletter or remove this statement all together.	This was an editorial oversight. The dates have been corrected in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	121	Page 5-2, 5-3 Statement: *In August 2009, BLM and the Forest Service initiated consultation via letter with the following tribal governments: Chemehuevi Tribe, Colorado River Indian Tribes, Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Las Vegas Paiute Tribe, Moapa Band of Paiute Indians, Pahrump Band of Paiutes, Paiute Indian Tribe of Utah, Pueblo of Zuni, San Juan Southern Paiute Tribe, Navajo Nation, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe. The Havasupai Tribe, Hopi Tribe, and Hualapai Tribe, Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah, Pueblo of Zuni, and Navajo Nation all requested active consultation.*	As part of the Section 106 process, BLM is required to comply with Section 101(d)(6)(B) of the National Historic Preservation Act, which requires federal agencies to consult with any American Indian tribe that "attaches religious and cultural significance to historic properties that may be affected by an undertaking" (36 CFR 800). Communication with knowledgeable persons in the mining industry is also vital to the analysis process.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			The BLM and Forest Service have had one or more project-related meetings with each of these tribes. A summary of the dates of and tribal entity (ies) attending these meetings is provided in Table 5.2-1. Tribes are being provided with a copy of this Draft EIS, and consultation and partnering will continue throughout implementation of the selected action alternative, if approved. Comment: It is interesting to note the number of tribes invited to consultation. It would appear that an assumption has been made about the number of tribes historically accessing the areas within the proposed withdrawal. It should be noted that in ancient times, the tribal members traveled by foot or by horse thus did not cover many miles in their travels. Noticeably absent is mention of any kind of consultation with the uranium industry. It would seem more than appropriate to consult with them on a regular basis to improve communication, verify information or misinformation and to obtain factual information about the previous mining experiences of the 1980s.	EIS Chapter 6, Literature Cited, documents the input that was obtained from Denison Mines Corporation, Energy Fuels Nuclear, Inc., Eugene Spiering of Quaterra Resources, Inc., and many others, both in the form of documents and personal communications.
American Clean Energy Resources Trust (ACERT)	225256	123	CHAPTER SIX - LITERATURE CITED Statement: All pages Comment: The preparers of this report know exactly which page numbers their references came from. It would be helpful to the reader to have immediate access to the reference instead of reading an entire document to get to the referenced material. At least one reference does not produce the statements referred to in the DEIS. Please correct this and add page numbers to the Literature Cited.	With the exception of referenced periodicals, it is not standard editorial practice to include page number citations in documents of this type. There is also no NEPA requirement to do so.
American Clean Energy Resources Trust (ACERT)	225256	124	Page 6-8 Statement: *Arizona Geological Survey (AZGS). 2002. Geologic Map of Arizona. GIS Database, v. 3.0. Edited by S.M. Richard. Arizona Geological Survey, 01-8. CD-ROM. --,.2010. Mission statement Available at: <http://www.azgs.az.gov/aboutshtml>. Accessed February 19, 2010. American Clean Energies Trust 2009. Economic Impact of Uranium Mining on Coconino and Mohave Counties, Arizona. Available at: <http://acertgroup.comlEconomic_Impactpdf>. Accessed June 1, 2010. Arizona Oil and Gas Commission. 2005. Oil and gas wells in the State of Arizona, 01-33. 1 CD ROM, digital well location map.* Comment: In the standard English alphabet Am comes before Ar. It is convenient how this reference was placed in the middle of all of the Arizona references. In addition, since you were on the ACERT website you could have taken the time to get the correct name of our organization which is American Clean Energy Resources Trust Unfortunately; this basic error in alphabetical listing does not bode well for those preparers trying to present this statement as a legitimate report with the "best available science."	These references have been corrected in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	125	CHAPTER 8 - INDEX Pages 8-1 through 8-9 Comment: A much more comprehensive index is needed. Because the document is very long and difficult to follow it is difficult and time-consuming to locate a specific section of the text. Portions of specific topics are discussed in several different sections of the EIS, and the entirety of a subject is generally not discussed in anyone section. The public will not be able to locate all	The Chapter 8 index is in conformance with CEQ requirements and current NEPA documentation standards (see 40 CFR 1502.10).

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			references to a desired topic without a comprehensive index.	
American Clean Energy Resources Trust (ACERT)	225256	133	USGS, SCIENTIFIC INVESTIGATIONS REPORT 2010-5025 Pages 116 through 119 Comment: This portion of the report deals with the investigation of the effects of 1980's uranium mining in Hack Canyon. The report fails to point out that the ore body within the Hack 1 breccia pipe (arrow 1 on figure 22, page 117) was breeched by erosion of the unnamed tributary to Hack Canyon (labeled "T" on Figure 22) prior to any mining activity. The highest elevation of uranium ore grade mineralization in known breccias pipes is near the lower contact of the Coconino Sandstone. Erosion has placed the "T" tributary's current base well below this horizon and deeply into the Hermit Shale at the mine site, indicating that a significant portion of these upper levels of mineralization were within the eroded portion of the pipe. Also, the Hack 1 Mine's highest stope was halted within 40 feet of the stream gravels when plant roots were encountered. This stope was backfilled during reclamation of the mine site. An estimate of the amount of material removed from the ore body by erosion prior to mining is not possible, but it is safe to assume that it was in the range of a few thousand tons. The USGS implies in Scientific Investigation Report 2010-5025 that all of the mineralized breccias found in the Hack drainage below tributary "T" is ore and mine waste from the August 19, 1984 flood event that removed an estimated 10 to 12 tons of material from a mine stockpile at the Hack 1 Mine. Such an assumption is erroneous since it would be impossible to tell the difference between the breccias eroded from the breccias pipe before mining from actual ore and mine waste. Given the difference between the volume of the erosion (a few thousand tons) and the August 19, 1984 flood event (10 to 12 tons), it is more likely that the material found by the USGS is from the erosion and not the result of the mining activity as they assert.	According to USGS, the mineralized samples found by USGS, as shown in Figures 27 and 28 (p. 123-124) of SIR 2010-502, were in the active part of the stream channel and appeared (as the sample photos in the report suggest) to be relatively fresh rock, not substantially weathered or eroded, and therefore more likely to come from the waste rock used in the reclamation of the site and re-worked by the flooding in the mid-1980s, and not from natural erosion that would pre-date mining. The boulder and chunks in Hack Canyon were entrained in the surface layers of the dry stream channel, and were located downstream of the mines and an eroded terrace composed of Hack Canyon mine waste material. The sulfides remain intact (unoxidized) in these boulders, which does not suggest they had sat in the stream channel for hundreds or thousands of years. Their chemistry matched ore and waste material from the Hack mines. Thus, USGS field observations suggest the mineralized boulders came from the eroded terrace filled with mine waste material adjacent to the stream channel of Hack Canyon. It is difficult to envision coherent blocks of this material on the surface of the stream channel derived from the erosion of a breccia pipe thousands or more years ago.
American Clean Energy Resources Trust (ACERT)	225256	134	The BLM prepared this document in collaboration with 15 federal, state, local, and tribal cooperators in an effort to provide an objective analysis of the Proposed Action and Alternatives based on the best available science. This DEIS has been prepared on behalf of the Secretary of Interior to inform his decision whether or not to withdraw lands in the vicinity of the Grand Canyon from the Mining law of 1872. This DEIS was developed in accordance with the National Environmental Policy Act of 1969 (NEPA), the Federal land Policy and Management Act of 1976, implementing regulations, the BLM's NEPA Handbook (H-1790-1), and other applicable laws and policy. The BLM may be the agency that has to claim this DEIS, however, the BLM is far more intelligent and has better science than contained in this report. Thus, it would be more appropriate to state that SWCA has used their best available science. That science is severely lacking in facts. There are far too many assumptions without basis to be considered a factual report on any issue in northern Arizona.	SWCA Environmental Consultants was selected as a contractor to assist in development of the EIS. All materials prepared and submitted by SWCA have been subject to BLM and Cooperating Agency review and approval. The science used in preparation of this EIS is cited in Chapter 6, Literature Cited.
American Clean		137	There is no mention at all of the stellar record of uranium mining by Energy	Documents from Energy Fuels Nuclear were

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Energy Resources Trust (ACERT)			Fuels Nuclear (EFN). The successful and safe mining activities in 1970s, 1980s and the early 1990s illustrates that uranium mining can be done in an environmentally conscientious manner. EFN's impressive history is uranium mining's proud legacy on the Arizona Strip.	extensively consulted during development of the EIS, particularly the Chapter 3 and Chapter 4 Water Resources sections; this study was supplemented by conversations with Roger Smith, former mine foreman for EFN. Please see Chapter 6, Literature Cited.
National Parks Conservation Association	225257	2	We ask that Alterative C and D be rejected for two reasons. First and foremost, the most significant potential impacts of uranium mining in this area are not localized. Radiation-laden dust can travel long distances. The complex aquifer system, should it be compromised by drilling or underground mining, can transfer radioactive material in ways not yet understood. Historic accidents have spread damage long distances down surface water drainages. There is really no reasonable way to forecast how the risks that are allowed by uranium mining in this area would be confined to only a percentage of this watershed, not as long as additional uranium exploration and development is permitted in some portion of it.	The purpose of this EIS was to evaluate the best scientific information available so as to allow the Secretary to make a decision regarding the proposed withdrawal. NEPA requires that other alternatives to the Proposed Action and the No Action alternatives be evaluated with equal rigor (see 40 CFR 1502.14 and Question 1 of the Council on Environmental Quality's Forty Most Asked Questions Concerning CEQ's NEPA Regulations). Alternatives C and D are valid alternatives derived by resource specialists, specifically developed to present a range of alternatives between the Proposed Action and the No Action alternatives that would also meet the Purpose of and Need for Action (EIS Section 1.3).
Energy Fuels Resources	225260	2	In Section 1.3.1 of the DEIS, the Purpose of the Action is described as *to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the segregated area.* The Need for Action is described in Section 1.3.2 of the DEIS as *concerns that future hardrock mining activities in the Grand Canyon watershed, particularly for uranium, could result in adverse effects on resources.* The first paragraph states that historic mines in the area date back to the 1860's and those impacts from these mines are primarily associated with older copper and uranium mines that were operated prior to the new regulations and permitting that mitigates potential issues. However, the DEIS analysis clearly shows that most of the projected impacts to resources are negligible or minor under the "No Action" alternative. Furthermore, the projections of moderate or major impacts are based on "worst case" scenarios that do not adequately take into account the mitigation that would be required under the site-specific NEPA analysis for each project. Accordingly, it is my belief that there is no need for action and that no further withdrawals of public land are justified.	The Secretary of the Interior was concerned enough about possible impacts to the watershed to consider withdrawal. As stated in Federal Register notice 74:108 (July 21, 2009), a key purpose of the Secretary's Notice of Proposed Withdrawal was "to allow time for various studies and analyses, including appropriate National Environmental Policy Act analysis. These actions will help inform the final decision on whether or not to proceed with a withdrawal."
Energy Fuels Resources	225260	3	As described in Section 2.4.1 of the DEIS, 4,998 square miles of lands in the vicinity of the proposed withdrawal area have been previously withdrawn from mining activity under national park, national monuments, and game preserve designations. This does not include other large land blocks controlled by various tribes in the region that have also declared uranium mining moratoriums. Further, as discussed in Sections 4.3.5 and 4.3.6 of the DEIS, approximately 50% of the 9,100 square miles	The purpose of the Secretary's Notice of Proposed Withdrawal and this NEPA evaluation is to enable an informed decision to be made regarding withdrawal that would ensure protection of "the natural, cultural, and social resources in the Grand Canyon watershed." The economic benefits of mining, while a critical component in the overall analysis, must be weighed

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			designated as high mineral potential for uranium in northern Arizona and southern Utah have been previously withdrawn from mineral location and entry. Under the Proposed Action, the land withdrawn would increase by 1,579 square miles to almost 70% of the land with high uranium potential. This proposed action is inconsistent with the Energy Policy Act of 2005 (Public Law 109-58), which emphasizes the reestablishment of nuclear power (Sections 601 through 657). Implementation of the proposed action would decrease our ability to meet the world demand for uranium which is projected to grow from approximately 189 million pounds in 2010 to 336 million pounds in 2020 (RBC Capital Markets, September 2010).	against numerous other resource considerations. The proposed withdrawal is consistent with the Energy Policy Act of 2005.
Energy Fuels Resources	225260	4	The Proposed Action is also inconsistent with the following federal legislation. The Domestic Minerals Program Extension Act of 1953, The Mining and Minerals Policy Act of 1970, The Federal Land Policy and Management Act of 1976, The National Materials and Minerals Policy, Research and Development Act of 1980, The Arizona Wilderness Act of 1984.	The proposed withdrawal is consistent with all of the Acts cited in the comment. The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and 4.13.
Energy Fuels Resources	225260	5	The executive summary appears to ignore the findings of the technical specialists and overstates the impacts of the proposed alternatives, especially Alternative A (No Action) for cultural resources, American Indian resources, aquatic and terrestrial habitats, and special status species when compared to the detailed analyses provided in Section 4 of the DEIS. Major direct impacts are not identified for any of these resources in Section 4 and it appears that the Executive Summary does not accurately represent the findings of the technical specialists. It is recommended that this section be entirely rewritten to correct statements that do not properly reflect the detailed analysis and that additional general information be included, especially the types of mitigation that are required by federal and state agencies to minimize impacts, which are incorporated into an approved Plan of Operations and are specified in the Decision Record.	The Executive Summary has been re-reviewed by the project team prior to finalization of the FEIS. Because the Proposed Action and Alternatives being analyzed in this EIS are various configurations of withdrawal from the Mining Law of 1872, mitigations to withdrawal are not appropriate. Mitigation measures will be incorporated into any future site-specific NEPA analyses conducted to approve specific Mine Plans of Operations.
Uranium Watch	225262	2	The EIS should provide a full assessment of the current condition of the existing and potential mining operations, such as soil contamination, ground and surface water contamination, extent of waste rock piles, and extent and success of remediation efforts and re-vegetation of areas impacted by previous uranium exploration and mining activities.	These conditions are described in Chapter 3, Sections 3.4 and 3.5.
Uranium Watch	225262	7	The DEIS assumes that all state and federal regulations will be complied with. There is no basis for that assumption. The recent record of compliance with state and federal regulations by Denison Mines (USA) Corporation (Denison Mines), the owner of existing and proposed uranium mines in the withdrawal area, is evidence that uranium mines will have problems.	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. Changes to current regulations governing mining are legislative actions or executive branch decisions that are beyond the scope

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				of this EIS. The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.
Uranium Watch	225262	8	The EIS should include a full description of the types of radiological and non-radiological contaminants that would be released from a uranium mine operation, the specific source of those contaminants, the state and federal regulations that apply to those contaminants, the regulatory program that would administer and enforce those regulations.	Potential contaminants are described in Section 3.4 of the Affected Environment, Water Resources, and 3.5, Soil Resources, as well as in the "Public Health and Safety" subsection of Section 3.15, Social Conditions. Applicable regulations are listed in Chapter 1, Section 1.4.3, Authorities.
Uranium Watch	225262	9	The EIS should demonstrate that the Arizona Department of Environmental Quality (ADEQ), the Bureau of Land Management (BLM), and U.S. Forest Service (USFS) have the staff, finances, and inspection and enforcement programs that will assure that the existing regulations will be complied with by the mine owners and operators.	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. The BLM and Forest Service regularly inspect mining operations. The BLM, under the 3809 Surface Management Regulations, inspects active operations two times per year, at a minimum, and conducts more frequent inspections when necessary. The minimum number of inspections for active operations on Forest Service lands is one time per year with more frequent inspections when necessary.
Uranium Watch	225262	12	The whole history of uranium mining is a story of disregard for human health and wellbeing and a disregard of the impacts to the environment. The DEIS assumes that such disregard is no longer present in the regulatory decision making process. That is clearly not the case. There will continue to be unacceptable risks and impacts from uranium mining, along with an inability of the regulatory agencies to fulfill their responsibilities to protect human health and the environment.	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. Changes to current regulations governing mining are legislative actions or executive branch decisions that are beyond the scope of this EIS. Nevertheless, in an effort to address this concern, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				agreement as to how to best coordinate their future monitoring and enforcement efforts in and around Grand Canyon National Park.
Uranium Watch	225262	14	Section 2.4.3, Alternative B: Proposed Action (20-Year Withdrawal); Alternative B Reasonably Foreseeable Future Activity. Page 2-14. This section states, in part: *Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time*. The statement that reclamation occurs once exploration or development is concluded is blatantly false. Reclamation of some of the land may commence when exploration or development ends, but it certainly will not be complete. Some disturbance from exploration and development will remain over the long term and be cumulative. Some of the land may be permanently disturbed due to the presence of waste rock piles. In an arid climate, it can take decades before the land returns to the same conditions that existed prior to development. Also, mines can remain on stand-by for decades, with little or no reclamation. The data related to land disturbance should have included a breakdown of the types of disturbance and the length of time it will take to restore the land to a pre-mining environmental conditions.	Mining-related soil disturbance, reclamation efforts, and associated timelines are discussed in greater detail in Chapter 4, Sections 4.5.2 and 4.5.3, and in Appendix B, Reasonably Foreseeable Development Scenarios.
Uranium Watch	225262	27	Section 4.1.1 Foreseeable Activity Assumptions. Pages 4-1 to 4-2. The EIS must assess the impacts of mines during times of non-operation when waste rock, stockpiled ore, low grade, and other aspects of the mine operations can contribute to adverse environmental impacts. Some uranium mine sites that have remained inactive for over a decade, with little site reclamation. Waste rock has been removed from mine sites, transformers have remained on site, mine vents have remained open, and other hazardous conditions have not been addressed at mines on standby. In sum, the BLM does not have a history of assuring that mines on standby are properly maintained.	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim management.
PEW Environment Group	225274	3	It is inappropriate for the analysis to dismissively conclude that impacts on water, wildlife, tourism, aesthetics and cultural values may range from minor to major, and from short-term to long-lasting. The true value of the resources at risk and the inherent uncertainties of prediction should be more forthrightly addressed, and the option chosen that offers the most certainty for preventing damage to the delicate ecosystems of the Canyon region.	Every effort was made throughout development of the DEIS to provide quantitative data wherever possible so as to enable a rigorous comparative analysis between alternatives. Guidelines to magnitude and duration of anticipated impacts were included to allow readers lacking technical expertise in a particular field, such as air quality or economics, to better understand what these data mean in a broader context.
PEW Environment Group	225274	16	The risks associated with milling and mill tailings disposal are substantial, particularly in an area subject to relatively high winds and frequent flash flooding. Any tailings disposal facility would have to be carefully managed,	No on-site ore processing or tailings are anticipated under any of the alternatives analyzed in the DEIS. All ore would be transported by haul truck from the project

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			not only through its operational life, but for decades to come. Under the Uranium Mill Tailings Radiation Control Act, this area would present a long-term radiation hazard and be permanently off limits to any activities or visitation. Such a use would clearly be incompatible with the natural resource protection goals of the broader area and the recreation use of the Park, the nearby Monuments and the nearby wilderness areas.	area for processing elsewhere (most likely to the White Mesa Mill near Blanding, Utah). If any on-site processing were to be proposed in the future, that proposal would be subject to a separate, site-specific NEPA analysis.
PEW Environment Group	225274	17	Another point on which the DEIS fails is its repeated assumption that mine operations will at all times be fully compliant with environmental laws and regulations and that such regulations will consistently offer adequate protections. An assumption of 100% compliance, 100% of the time is, without doubt, at odds with reality, this assumption should not be used even as the basis for a "best case scenario." Even under the management of highly competent and well-capitalized operators and enhanced oversight by regulatory agencies, accidents, spills and other problems may occur from time to time, and must be considered.	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. Changes to current regulations governing mining are legislative actions or executive branch decisions that are beyond the scope of this EIS. NEPA does not require a worst-case scenario analysis (this analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618, Apr. 25, 1986), only analysis of circumstances that are reasonably foreseeable is required. Appendix B provides this reasonably foreseeable development scenario and provides a rationale to why this scenario is used. However, the analysis did assume the potential for vehicular accidents involving haul trucks and for other risks to human health. See the Chapter 4, Section 4.15, Social Conditions, Subsection Human Safety Risks (DEIS pages 235-239).
Center for Biological Diversity	225279	2	The DEIS states, *For purposes of this EIS, it must be assumed that state and federal regulations have been and are being met.* DEIS at 4-57. The DEIS relies on that assumption throughout its analyses to conclude that uranium mining and exploration would not cause environmental damage. A discussion of the fallacy of these assumptions and thus the inadequacy of existing regulatory mechanisms follows in these comments. See Support for Proposed Action section and subsection "c" immediately below in these comments.	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. Changes to current regulations governing mining are legislative actions or executive branch decisions that are beyond the scope of this EIS. Nevertheless, in an effort to address this concern, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				agreement as to how to best coordinate their future monitoring and enforcement efforts in and around Grand Canyon National Park.
Center for Biological Diversity	225279	3	The DEIS consistently downplays the impacts of past, current and potential future uranium mining on the proposed withdrawal area and Grand Canyon National Park while exaggerating its potential economic benefits.	The impacts of past, current, and future uranium mining have been disclosed in the EIS as completely and accurately as the available science allows, sufficient to compare alternatives and to inform the decision by the Secretary of Interior. The FEIS has included a more refined description of the current economic conditions in Section 3.17 analysis in Section 4.17.
Center for Biological Diversity	225279	4	The DEIS presumes that existing regulatory mechanisms will be followed and will prevent pollution; facts demonstrate that existing regulatory mechanisms are inadequate, not consistently followed or enforced, and are not implemented in a way that prevents pollution.	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. Changes to current regulations governing mining are legislative actions or executive branch decisions that are beyond the scope of this EIS. Nevertheless, in an effort to address this concern, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to agreement as to how to best coordinate their future monitoring and enforcement efforts in and around Grand Canyon National Park.
Center for Biological Diversity	225279	10	By grouping effects into categories of severity, the DEIS undermines the comparison of alternatives by precluding a discussion of relative impact of effects grouped in common categories.	It is unclear what portion of the DEIS this comment refers to.
Center for Biological Diversity	225279	13 & 14	As described below, facts do not support the DEIS's assumption that compliance with existing regulatory mechanisms will occur or will prevent harmful effects from mining and exploration. Ensuing analyses throughout the DEIS that discount the possibility of effects stemming from non-compliance, or that are based on an assumption that non-compliance will not occur, are therefore invalid and underestimate the potential environmental impacts that could result from mining and exploration activity. The DEIS states, *For purposes of this EIS, it must be assumed that state and federal regulations have been and are being met.* DEIS at 4-57. The DEIS relies on that assumption to conclude that uranium mining and exploration would not cause environmental damage. For example, the	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. Changes to current regulations governing mining are legislative actions or executive branch decisions that are beyond the scope of this EIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			DEIS further states, *In accordance with current regulations, impacts to water resources resulting from mine operations are reduced and controlled by way of implementation of appropriate design features and standard operating procedures.* DEIS at 4-66. But as is evident by the State's regulation of ground water, Arizona completely ignores contamination of the aquifer from a mine shaft and refuses to require aquifer monitoring. BLM's assumption that uranium mining companies will follow applicable laws and regulations, or those responsible agencies will ensure those laws and regulations are followed, is not supported by facts. As reported in the Arizona Daily Sun's article "Mining on the Honor System," ADEQ's first inspection of the Arizona mine in September 2010, nine months after the mine had commenced operations, yielded four major violations: (1) There were no pumps in the mine to eliminate any water there, as was required; (2) A test measuring the permeability of the rock in the mine hadn't been done, as was required; (3) A pipe was sticking through a lined pond that is intended to prevent groundwater contamination from ore or water pumped out of the mine. (4) Plans for the mine didn't match what inspectors found when they visited. Those violations were ongoing for nine months for lack of any regulatory oversight from BLM, ADEQ, EPA or any other regulatory agency. Similarly, a site visit by Center for Biological Diversity staff to inspect exploratory drilling operations by VANE Minerals in 2009 documented drilling operations in violation of conditions set forth in the Forest Service Decision Memo authorizing that activity: (1) Drilling residues were required to be contained in a closed container or open fluid waste pits; drilling residues were instead dumped into an open truck trailer that in turn leaked residue into Deer Creek Wash, two miles from the boundary of Grand Canyon National Park. (2) Drilling residues, if left an open fluid waste pit, were required to be netted on the top to prevent access to the pits by birds; there was no netting to prevent birds from being exposed to drilling wastes. Drilling waste was left in the wash. (3) The Decision Memo required open fluid waste pits to be fenced along the sides to protect wildlife; neither the trailer nor the drilling waste that flowed into and down Deer Creek Wash were fenced to prevent wildlife exposure. McKinnon Declaration at 2. (Appendix 1). In the former case, the Arizona 1 mine had been reopened for nine months prior to ADEQ's first inspection in September 2010; the four major violations it yielded had been ongoing for nine months for lack of any regulatory oversight. In the latter case, the U.S. Forest Service had not visited VANE's exploration site, or had visited it and not enforced conditions of the authorizing Decision Memo. Neither case demonstrates voluntary industry compliance with law or regulation. Neither case demonstrates a capacity among responsible agencies to monitor or ensure compliance with laws and regulations in a consistent, timely manner. Both cases demonstrate industry non-compliance with laws and regulations. Both cases demonstrate failure by responsible agencies to ensure that applicable laws and regulations are followed while mining	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			and exploration activities are underway.	
Center for Biological Diversity	225279	15	The chasm separating the DEIS' regulatory aspirations from regulatory reality is found in the DEIS itself: Reclaimed sites are monitored on a regular basis after closure to evaluate the effectiveness of the reclamation actions and to maintain the designed features against erosion. DEIS at 4-101. The DEIS then states: Detailed documentation of specific reclamation results for the five reclaimed mines (Hack 1, 2, and 3; Hermit; and Pigeon) on the North Parcel was either incomplete or unavailable for this analysis. General documentation was available in documents submitted to the administering agencies, and helpful details were obtained from discussions with former mine personnel. DEIS at 4-66. The DEIS' own facts undermine its assumptions by demonstrating the failure of responsible agencies to ensure that applicable laws and regulations are followed.	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. Changes to current regulations governing mining are legislative actions or executive branch decisions that are beyond the scope of this EIS. Nevertheless, in an effort to address this concern, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to agreement as to how to best coordinate their future monitoring and enforcement efforts in and around Grand Canyon National Park.
National Mining Association	225281	3	To some degree the department acknowledges the role of existing regulations but the DEIS should contain a more complete picture of the comprehensive framework of federal and state environmental, ecological, and reclamation laws and regulations that ensure operations are fully protective of public health and safety, the environment, and wildlife. Indeed, any proposed mining project would be evaluated as required by each of these laws to ensure that mining could be completed in a manner that is protective of the environment.	Applicable laws and regulations are identified and discussed in Chapter 1, Section 1.4.3, Authorities. Additional information is provided in Appendix B, Reasonably Foreseeable Development Scenarios, Section B.3, Regulatory Framework.
Ted Jensen	225282	4	Missing from the study is the previous withdrawal of lands with the expansion of the Grand Canyon boundaries to allow for a greater buffer zone. Additional Grand Canyon buffer area were added with the addition of the Grand Canyon Parashant National Monuments and designated wilderness areas in the Vermilions and Kanab Creek areas.	The establishment of the Grand Canyon Parashant National Monument and the designation of the Vermilion Cliffs and Kanab Creek Wilderness areas did not alter the status of lands within the three parcels proposed for withdrawal with respect to mineral exploration and development. The status with respect to mineral entry of these and other special designation lands are described in DEIS Chapter 3, Section 3.1.
Ted Jensen	225282	5	Missing is a description of the compromises and agreements reached with the addition of the Grand Canyon Parashant National Monument. This provided a huge buffer area to the Grand Canyon. President Clinton and Secretary Bruce Babbitt added this monument and agreement was reached to allow the remainder of the Arizona Strip to be open for exploration. The North Segregation area is within this open area and now those agreements are being ignored.	The establishment of the Grand Canyon Parashant National Monument did not include any provision that the remainder of the Arizona Strip was therefore open to mineral exploration and development. Presidential Proclamation 7265, which created the Monument, provides the Purpose of the National Monument and the framework for its creation.
Ted Jensen	225282	7	It appears the measurement magnitude scales (minor and major) are	The impacts of past, current, and future uranium

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			incorporating land areas that are not really subject to mining. Not all claims will even be explored; yet, area impact measurements appear to include these areas. This dramatically skews the summary results and is very misleading.	mining have been disclosed in the EIS as completely and accurately as the available science allows, sufficient to compare alternatives and to inform the decision by the Secretary of Interior. Although only a small fraction of mining claims would eventually be mined, the assumptions for mineral development for each alternative that was used to estimate impacts are described in Appendix B, Reasonable Foreseeable Development.
Ted Jensen	225282	16	The Executive Summary states that alternatives are subject to valid existing rights (page ES-1). Missing is a clarification that this really means most claims will be void and only those with drilled verified results are considered valid.	The process of determining valid existing rights to mining claims that pre-date the notice of proposed withdrawal is outside the scope of this FEIS. To the extent mining claim validity determinations interact with the RFD analysis, they are discussed in Section B.8.2 of Appendix B.
VANE Minerals	242650	3	The United States Geological Survey was charged with producing USGS Scientific Investigations Report 2010-5025 (USGSsir2010-5025) to provide data for the EIS. Although, the DEIS relies heavily on data from this report, nowhere in the DEIS is it explained that USGS Scientific Investigations Report 2010-5025 was completed for the expressed purpose of the EIS. It should be noted that none of the credentials of the authors of USGSsir2010-5025 are provided to authenticate their qualifications for this project. Specifically, with respect to Chapters A and B which present mineral exploration and mining data, it is not clear whether the authors are geologists or have a background in mining. Further to this, the editor of USGSsir2010-5025, Andrea Alpine, is not a geologist or mining engineer. The data provided for the DEIS is flawed from the intrinsic reason that, given the main issue in the withdrawal is mining, the United States Geological Survey should have charged the responsibility of this to a geologist or engineer with mining qualifications. The need to ensure that the best qualified people are put on this project is critical since the EIS process is for the purpose of deciding whether to withdraw a large tract of land for 20 years and thereby permanently affecting people's lives. The DEIS should clearly state what the purpose of USGSsir2010-5025 was, the credentials of the authors with respect to their being qualified, and the fact that this document is heavily relied on and referred to in the DEIS.	USGS has expertise recognized by the federal government that qualifies them to produce scientific investigations. They were specifically tasked by the Department of Interior with conducting the investigations documented in SIR 2010-5025. Qualifications of the authors of SIR 2010-5025 are available from USGS.
VANE Minerals	242650	10	Section 1.4.3, Authorities, does not list the Arizona Strip Wilderness Act of 1983. The DEIS does not mention that the withdrawal is in direct conflict with this act and implementation of the withdrawal would likely violate this act and therefore be illegal.	The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and 4.13. The proposed withdrawal and alternatives are consistent with the act.
VANE Minerals	242650	14	The DEIS continually uses the term "could" in describing potential impacts. This interpretation is clearly flawed in that it is not quantitative. The basis for a withdrawal is not justifiable on the qualitative term "could", but must	The EIS includes quantitative data wherever it was applicable and available. Please refer to Chapter 6, Literature Cited, for these sources. Known data gaps,

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			be justified based on quantitative impacts described as "will" or "would".	by resource, are identified in the "Incomplete or Unavailable Information" subsections of Chapter 4.
Kris Hefton	242651	1	Paragraph 1 on Page ES-l of the DEIS states, *The withdrawal was proposed in response to increased mining interests in the region's uranium deposits, as reflected in the number of new mining claim locations. . .*This is a misleading statement and I would like to clarify the facts: 1) The number of new mining claims is about 1/3 of the number of claims that existed in the district in the early 1980s, at which time the Arizona Strip Wilderness Act of 1983 was implemented as a mitigating action. 2) The current proposed withdrawal is the result of various environmental groups including Grand Canyon Trust, Center for Biological Diversity, and the Siena Club, lobbying Former Secretary of Interior, Dirk Kempthome to withdraw the acreage. Secretary Kempthome refused on the grounds that there was no evidence of long-term irreparable harm nor did an emergency condition exist. Upon being elected, President Obama appointed Ken Salazar to Secretary of Interior and he soon issued the segregation order and proposed withdrawal of the 1M acres. There is insufficient data to indicate to any reasonable authority that uranium exploration and mining activities would cause immediate or long-term environmental harm. Clearly, this illustrates the political involvement in this issue whereby a decision was made on subjective, rather than objective reasoning. 3) The environmental lobby base their recommendation and support of the withdrawal on preserving the Grand Canyon for recreation and tourism. Recently, these environmental interest groups have challenged the company over rights of the Grand Canyon which resulted in public hearings in Phoenix. This is a direct contradiction to their reasoning for support of the withdrawal in favor of protecting the interest of tourists. These facts should be placed in the DEIS.	The purpose and need for the proposed withdrawal is defined in DEIS Chapter 1, Section 1.3. A brief history of the project is included in the Background discussion of Chapter 1, Section 1.3.
Arizona Rock Products Association	242654	1	The National Materials and Minerals Policy Research and Development Act of 1980 specifically, Title 30 Chapter 28 § Section 1601-1604 includes provisions in order to identify materials needs and assist in the pursuit of measures that would assure the availability of materials critical to commerce, the economy, and national security. The policy recognizes that the availability of materials is essential for national security, economic well-being, and industrial production in the U.S. Conversely, the proposed withdrawal at any level would have the opposite effect.	The proposed withdrawal is consistent with the Mining and Minerals Policy Act of 1970 (30 USC 21 *et seq*.). Mineral Material availability would not be affected by any withdrawal analyzed in this EIS. Furthermore, the Secretary of the Interior retains the authority to approve withdrawals as provided in Section 204 of the Federal Land Policy and Management Act of 1976 (43 USC §§ 1701-1782) and by the rules and regulations contained in 43 CFR 2310. The Secretary of the Interior also has the authority to revoke a withdrawal under FLPMA.
Arizona Rock Products Association	242654	2	Significant concern that access to either State Trust or private lands from federal lands for mineral exploration projects or for any roads or utility easements required for new mine development will become more difficult if this land is removed from entry. If the withdrawal is authorized, the DEIS does not address the ability of a permittee on state or private lands to	Neither the proposed withdrawal nor any alternative withdrawal would have any effect on rights-of-way (ROWs) or access to non-federal lands within the project parcels. ROW applications would continue to be processed as before. FEIS Section 2.4 has been

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			obtain a right-of-way across the federal lands that are closed to mineral location or entry. Clearly, this is a significant omission in the DEIS because these right-of-way limitations could serve to effectively increase the withdrawal area or expand the exclusion to include common minerals without an appropriate evaluation of impacts as required in the NEPA process.	revised to provide clarification on this issue.
Arizona Rock Products Association	242654	7	The DEIS notes that the no-action alternative would rely on the existing entitlement requirements and environmental programs to protect the resources in the Grand Canyon watershed. ARPA takes issue with this statement because it implies that the basic need for the withdrawal is to compensate for an inadequate existing federal, state and local regulatory framework.	The purpose and need for the proposed withdrawal is defined in DEIS Chapter 1, Section 1.3.
Arizona Rock Products Association	242654	8	ARPA believes that the difficulty of establishing a Valid Existing Right (VER) and obtaining approval of a reasonable Plan of Operations results in the Reasonably Foreseeable Development (RFD) significantly over-estimating the amount of potential future development in the withdrawal area. Again, this substantially underestimates the magnitude of the uranium resources lost to the withdrawal.	In addition to experts within the BLM, Forest Service, and USGS, numerous representatives of mining interests were consulted during development of the RFD. These sources are identified in EIS Chapter 6, Literature Cited, and in Appendix B, Section B.10, Literature Cited.
Arizona Rock Products Association	242654	10	The DEIS fails to demonstrate that future mineral development (under the no action alternative) would have no more than a minimal impact to the environment. ARPA is concerned that if any withdrawal can be justified on the basis of the poorly-documented Environmental Consequences (Chapter 4) than any future reversal of the withdrawal could never be justified.	The Secretary of the Interior is required by law to review withdrawals prior to expiration and issue a new decision as to renewal, extension, or termination of the withdrawal. See Section 204 of the Federal Land Policy and Management Act of 1976 (43 USC §§ 1701-1782) and the rules and regulations contained in 43 CFR 2310.4.
Friends of the Arizona Strip	242663	2	We find it both disturbing and unsettling that this Draft Environmental Impact Study makes absolutely no mention whatsoever of the 1984 Arizona Strip Wilderness Act and that at least two of the environmental groups who were a party to the agreements made back then have reneged on the promises they made.	The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and 4.13.
Quaterra Resources, Inc.	242664	6	The EIS is strangely silent on a number of issues germane to a decision on whether to withdraw these lands from mineral exploration and development, and more importantly would give an uninformed reader a sense of perspective and balance. These issues include 1) the contamination of the entire area by atmospheric testing of atomic devices by the US government.	We recognize that there were historical issues with radioactive fallout within the withdrawal parcels. The FEIS has been revised in Section 3.2 to include discussion of this history.
Quaterra Resources, Inc.	242664	11	There is a significant unaddressed issue of rights-of-way across federal lands in the withdrawal area. Federal land access to either State Trust or private lands for mineral exploration projects, or for any roads or utility easements required for new mine development, previously required a right-of-way agreement with either the Bureau of Land Management (BLM) or the U.S. Forest Service (USFS). If a withdrawal is authorized, the DEIS	Neither the proposed withdrawal nor any alternative withdrawal would have any effect on rights-of-way (ROWs) or access to non-federal lands within the project parcels. ROW applications would continue to be processed as before. FEIS Section 2.4 has been revised to provide clarification on this issue.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			does not address the inability of a permittee on state or private lands to obtain a right-of-way across the federal lands that are closed to mineral location or entry. This issue also relates to private, state and public lands that are outside the withdrawal boundary but are essentially unavailable for mineral entry because these isolated parcels of lands are essentially landlocked by previously withdrawn federal lands. Clearly, this is a significant omission in the DEIS because these right-of-way limitations would serve to effectively increase the withdrawal area without an appropriate evaluation of impacts as required in the NEPA process.	
Quaterra Resources, Inc.	242664	18	In several sections, the DEIS notes that Alternative A would rely on the existing entitlement requirements and environmental programs to protect the resources in the Grand Canyon watershed. By implication, these statements suggest the basic need for the withdrawal is to compensate for an inadequate existing federal, state and local regulatory framework that for some unknown reason cannot protect the valuable environmental, cultural or biologic resources in the area. However, the data presented in Section 3 clearly indicate that the existing entitlement process along with state and federal environmental regulations surrounding mine exploration and development are more than adequate to protect valuable environmental, cultural or biologic resources. For instance, in Section 3.2.2, the DEIS requires 7 pages to briefly outline the various state and federal programs regulating air quality. Similarly, Section 4.4.3 identifies that: *In accordance with current regulations, impacts to water resources resulting from mine operations are reduced and controlled by way of implementation of appropriate design features and standard operating procedures. Active mine sites are routinely audited for compliance with their approved plans of operation and other permits.* Coupled with the myriad of engineering and permitting practices discussed on pages 4-66 and 4-67, and the vast number of state and federal agencies who regulate the complex network of permits and entitlements, it's difficult to envision some inherent inadequacies of the existing regulatory framework that would promote the wholesale degradation of the environment. Notwithstanding the operational permits required for development, the National Environmental Policy Act (NEPA) establishes a complex framework for considering the application for development of a mineral resource on Federal lands and for identifying and mitigating any significant physical, biologic, cultural, environmental, historic, tribal and socioeconomic impacts. This NEPA process is intentionally focused on the eliminating or mitigating the direct and indirect impacts of a particular proposed action while the existing environmental regulations are intended to prevent the "release or potential release" of any regulated compound or constituent to affected media like air, water or soils.	The current status of applicable environmental laws and regulations (see FEIS Chapter 1, Section 1.4.3, Authorities) does not alter the underlying purpose and need for the project, which is identified in Chapter 1, Section 1.3, Purpose of and Need for Action.
Quaterra Resources, Inc.		19	Section 204 of the Federal Land Policy and Management Act allows for withdrawals to be renewable as long as the underlying reason for the	The Secretary of the Interior is required by law to review withdrawals prior to expiration and issue a new

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			withdrawal is still valid. Because the DEIS fails to demonstrate that future mineral development would have no more than a transient impact to the environment, the DEIS has essentially lowered the impact threshold to such a point that any future reversal of the withdrawal could never be contemplated.	decision as to renewal, extension, or termination of the withdrawal. See Section 204 of the Federal Land Policy and Management Act of 1976 (43 USC §§ 1701-1782) and the rules and regulations contained in 43 CFR 2310.4.
Bryan Bates	242723	1	Third, in the State of Arizona, the permitting for mining falls to the air quality program. Air is an issue, but given the density of radionuclide's, most fall near the source thus affecting miners and local biota, unless transported to a distant site for processing. The sphere most likely to be heavily affected is the hydrosphere, but water quality does not have standing in this case due to the dysfunctional nature of some governmental machinations. The key point however is that the State is severely in debt. Thus all services, especially the perceived expendable services of the State Environmental Protection Agency have been severely curtailed to the point where the State EPA is dependent on the mining company to report and correct its own shortcomings. (See enclosed article from Arizona Daily Sun). This "fox guarding the henhouse" scenario is particularly unsettling when one considers that Dennison Mining has been cited for several violations of environmental regulations and the pattern is not likely to change with a decrease in regulatory oversight. Even when State EPA officials were available, the quality of their work appears to be lacking, this in a state where the Governor's mining advisory board is wholly composed of mining corporate executives and employees (See article referred to above.)	NEPA analyses such as this EIS are not conducted under the assumption that a mining company--or any other entity--would operate in violation of existing laws. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary. The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, National Park Service, and U.S. Geological Survey have agreed to initiate formal talks with ADEQ so that all five agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.
The NAU Project, LLC	242913	13	There should be a Background Section that gives the historical context for the current situation. The Arizona Wilderness Act of 1984 set the stage for the areas that are open to mineral entry and provided the necessary certainty for mineral development. There is absolutely no mention of this law in this DEIS at all. There is no mention that this was a landmark bill that stakeholders involved in the 1980's came together and through compromise set aside more land that was not open to mineral entry while defining those that were.	The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and 4.13.
The NAU Project, LLC	242913	14	Page ES-6 and ES-7 Each Alternative should contain a statement that each proposed uranium mine will have to undergo its own NEPA report along with all the public inputs and meetings as this EIS report is subject to.	Both BLM and Forest Service require analysis under NEPA before approving a mining plan of operations.
The NAU Project, LLC	242913	20	Page 1-15 The Arizona Wilderness Act of 1984 is not listed. This act was the cornerstone legislation that defined the areas that would be open for mineral entry around the Grand Canyon. This Act and a discussion of what was negotiated at the time should be included in this EIS, both in Chapter 1 and in the Wilderness Sections. The American Indian Religious Freedom Act could use some clarification. From the Canyon Mine EIS: The American Indian Religious Freedom Act requires that Federal Agencies	The FEIS has been revised to include information on the 1984 Arizona Wilderness Act in Sections 3.13 and 4.13. The EIS description of the American Indian Religious Freedom Act in Chapter 1, Section 1.4.3, Authorities, has been expanded to clarify that this law, designed to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			consider Native American beliefs and practices in the formulation of policy and approval of actions. The intent of the Act is to insure for traditional Native religions the same rights of free exercise enjoyed by other religions. However, it does not afford Indian religions a more favored status than other religions, but only insures equal treatment. The Act does not mandate protection of Tribal religious practices to the exclusion of all other courses of action. It does require that Federal actions be evaluated for their impacts on Indian religious beliefs and practices. I think the above statement should be included in Chapter 1 and in the Chapter 4 section on Indian resources.	protect American Indian rights of religious freedom, does not mandate that American Indian concerns are always paramount, but only that the federal government will consider their concerns in its decisions.
The NAU Project, LLC	242913	98	The basic philosophy of this current Draft EIS is to substitute the "judgment" of a global EIS over the "judgment" of site and project specific Environmental Impact Statements. This concept creates cumulatively and speculatively higher impact ratings assigned to issues due to the uncertainties provided by non-site specific analysis. Recall, that even if the no action alternative is chosen, each proposed mining "Plan of Operation" is still required to have its own site specific Environmental Impact Statement, giving the project a full measure of scientific and public scrutiny. The site specific EIS must also address most, if not all, of the issues in this current EIS. A global approach can determine if there are issues that are of such glaring and devastating impact that the endeavor being scrutinized should be modified or prohibited. This Draft EIS, as flawed as it is, does not identify any such devastating impact to the Grand Canyon area from uranium mining and exploration.	The purpose and need for this particular action is identified in EIS Chapter 1, Section 1.3. Both BLM and Forest Service require analysis under NEPA before approving a mining plan of operations.
The NAU Project, LLC	242913	99	Impacts determined under this Draft EIS should properly be divided into two groups for analysis. One group of impacts is from exploration and the other is from actual development and mining operations. While the impacts from each of these separate activities are analyzed, they are grouped together since they occur and overlap each other over the 20 year time scale considered by the EIS. This actually provides a biased view of the overall impacts due to exploration and actual mining operations. For example, this Draft EIS projects under Alternative A, the no action alternative, that 728 additional exploration projects would occur to discover the remaining ore deposits predicted by Appendix B. The exploration projects disturb about 1.1 acre each and last for about one month for a total of 801 acres disturbed. The overall level of disturbance is very small. Mining operations were projected to disturb about 22 acres each for a duration of about 4 years. A total of 563 acres would be disturbed by mining operations in total. Due to the greater length of time used by mining operations, the actual time-use of land for exploration is only 2.5% of the time-use of land for mining operations. This leads to the conclusion that uranium exploration and specific mining projects are actually two very separate activities and should not be strictly "combined" to measure impacts. The level of impact due to uranium exploration has been	It would be highly speculative to make assumptions as to where in the project parcels or the timeframes in which any exploratory projects and/or development projects might occur. They may or may not be grouped in particular geographic areas and may or may not occur simultaneously or gradually over a period of years. There is therefore is no basis to separate these activities in the analysis.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			determined by this Draft EIS to be minor in most cases and moderate in some few others. Excerpts from each of the Environmental Impact sections of this DEIS illustrates this point and are shown in Attachment 1 of this document. I have added comments to these excerpts where I felt needed. ****see submittal #242319 for attachment 1 information**	
The NAU Project, LLC	242913	100	Nearly all analyses of impact contain a caveat that the analysis contains greater uncertainties due to the "overarching" level of analysis and that project specific studies under an individual project EIS would provide better and more certain analysis. Examples of such qualified statements from Chapter 4 are submitted for review below: ****See submittal #242913 for more detailed information**	In numerous places the DEIS points out that site-specific analysis NEPA will yield more concrete conclusions regarding likely impacts. This does not mean that site-specific analysis for every potential future mineral exploration or development proposal must be carried out before the stated purpose and need of this EIS can be met, which is to provide analysis of the potential impacts of a withdrawal, not of specific mining projects (see Chapter 1, Section 1.3, Purpose of and Need for Action).
Connor	243244	1	We are all signing this letter to let Denison Mines Company know that we are all against the hauling of uranium ore through any part of the Navajo Nation. What kind of environmental questions would come up if this was hauled through Metro Phoenix or any major city? It shouldn't be any different here.	Particular ore haul routes would be identified and the potential impact of use of these routes would be assessed during site-specific NEPA analysis. This level of analysis was not within the decision-making framework of the Northern Arizona Proposed Withdrawal EIS. However, the FEIS has been revised to reflect the commenter's concerns in Chapter 3, Section 3.16, Social Conditions.
Alicia Sullivan	102970	3	As a GIS professional I am concerned about the methods used in this portion and other portions of the analysis. My concern is based on these methods and the fact that no information provided about the accuracy, collection method or age of the data used in these analysis. Without disclosing the accuracy of data the entire analysis is brought into question.	All GIS data used throughout the EIS are the best available in terms of relevancy, content, condition, and spatial accuracy for the anticipated project lifecycle. Datasets were often updated as new information was provided. In addition, most datasets were provided by the BLM and other cooperating agencies that included state and local agencies. Metadata documentation is part of the record and is available for review.
Greg Webb	103019	1	I do question some assumptions on which the alternatives were developed, specifically alternatives C and D. Your system for deciding what areas to set aside for withdrawal, in these alternatives, seems to center around identifying sections where more than one 'resource' overlap as being those most critical for withdrawal. It also seems to identify some fairly large areas as having ZERO resources, specifically in the North parcel, despite the fact that those areas have hydrologic features such as streams running through them.	As disclosed in Chapter 2 of the DEIS, the BLM and cooperating agency managers and scientists—as a group and as separate resource-specific teams—initially decided on several general parameters that could be changed in order to develop a range of reasonable alternatives that would meet the purpose of and need for action, minimize impacts to resources, and address the key concerns identified in scoping. These parameters are disclosed in Section 2.2 of the DEIS.
Greg Webb	103019	5	I would ask that in the final EIS, the hydrology element be re-assessed to recognize the uncertainties in the data you are using, to recognize the dual	Data uncertainties are acknowledged. Please see Section 4.4, Water Resources, Subsection 4.4.2,

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			nature of hydrologic resources as BOTH Water Quality and American Indian resources, and to, therefore, recognize Alternative B as the preferred alternative for this proposal.	Incomplete or Unavailable Information, Section 4.11, Cultural Resources, Subsection 4.11.3, Incomplete or Unavailable Information, and Section 4.12, American Indian Resources, Subsection 4.12.3, Incomplete or Unavailable Information. The Preferred Alternative was selected by the Secretary of Interior on June 20, 2011, as the Proposed Alternative, Alternative B.
Joseph Turner	246049	1	I am particularly interested in the Honorable Secretary of Interior's characterization of the "... best science available." I am not sure that the best science available can be assembled in these compressed time frames. Also when I analyzed chapter six, I found that less than 20 percent of the articles were from academic sources subject to the level of review deserving the distinction II peer reviewed." Could marks be made next to articles in the reference section to show that the articles have been subject to peer-review? Are determinations being made by a scientific consensus, experiments, or some other standard? From my observation of the agency I would say that it is not always the "... best science available," but what I would call "less than arbitrary" program management standards that try to balance expertise from different disciplines. It is well done, and the scientists are competent, but I think these documents should not just be voluntarily reviewed, they should have to be fully peer reviewed.	The best available data are not always peer-reviewed as sometimes peer-reviewed literature is not available for specific topics. USGS and other agency experts and scientists were consulted during the EIS development process and provided the most current data available to them.
Joseph Turner	246049	2	If and when there is a legitimate conflict in view expressed by a researcher, academic, or equivalently qualified cultural expert, over an issue that the agency chooses not to consider or include, could in-text foot- or end-notes refer the reader to as much information as possible? For example, could the public be referred to the researchers, agencies, institutions, and major publications holding the dissenting view, if they are willing to be identified as such? To me this is especially important for only the most crucial assumptions in the document, such as ones that would heavily alter figures for probability of adverse impacts.	The sources used in development of the EIS are identified in Chapter 6, Literature Cited. There is no requirement to distinguish between peer-reviewed and non-peer reviewed sources, nor to subjectively assess whether an author "assents" or "dissents" from the data or conclusions presented in the EIS.
Joseph Turner	246049	3	Many feel as these documents try to WOW the public," or make them feel overwhelmed and under qualified to approach the perspective of the authors. Since many in the public will never be formally trained, the extra information such as peer review standards, information regarding time constraints on studying the issues, and legitimate dissenting views, being fully and clearly presented will help the public maintain a coherent view of what is sometimes very complicated and contested scientific findings.	The sources used in development of the EIS are identified in Chapter 6, Literature Cited. There is no requirement to distinguish between peer-reviewed and non-peer reviewed sources, nor to subjectively assess whether an author "assents" or "dissents" from the data or conclusions presented in the EIS.
Joseph Turner	246049	4	A lot can happen in 20 years, and I think it is CLASSIC that the Director of the EIS claimed, when referring to the stability of the uranium market at the open house, that a major nuclear catastrophe was virtually impossible in today's nuclear practices. This is a great instance of how trends in thinking amongst those with political positions limit the scientific viability of these documents. I understand that many avenues of reasoning may be	NEPA does not require a worst-case scenario analysis (this analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618, Apr. 25, 1986), only analysis of circumstances that are reasonably foreseeable is required. Appendix B provides this reasonably foreseeable development scenario and provides a

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			politically problematic, and maybe even beyond the authority of the law on occasion, but science is not supposed to focus too much on what is sacred, but what is true. Perhaps appendices could be added express some of the more oddball scenarios. I think I was told that they couldn't "speculate," but honestly there are many reasonably foreseeable developments, and they all take a lot of speculation. In fact, isn't speculation a major part of Science?	rationale to why this scenario is used.
Joseph Turner	246049	9	Risk management includes risk perception, and this activity will ALWAYS be at odds with Native American culture, even if occasional tribes decide otherwise; maybe the impact statement should elucidate on this very point. In other words, the safety of this activity will always be viewed with skepticism or outright alarmism by the Native American community; perhaps we should protect the character of the region without placing a further burden on our anthropologically significant neighbors sentiments and cultural identity. If a value could be placed on their relationship to the land, I bet it would exceed the potential gains to society from this activity.	The EIS discusses the potential impacts to traditional use areas from anticipated mineral exploration and development activity, the likelihood of concurrent or overlapping timing of traditional activity with mineral exploration and development activity, the manner and degree of auditory or visual disruptions in the traditional use area, and the number or acres of key springs, plants, or traditional use items lost or damaged as a result of exploration and development activity. See Chapter 4, Section 4.12, American Indian Resources.
NEPA: General Cumulative Impacts				
Grand Staircase Escalante Partners	106647	2	Impacts on Grand Staircase Escalante National Monument. There was no consideration given for GSENM resources and recreational values. When questioned about this deficiency at the Fredonia public meeting, the staff's response was GSENM was outside the study area. It appears that decision was based on the fact that GSENM is located one foot over the Utah/Arizona state line. Impacts to resources and values do not stop at the state line. DEIS Figure 3.2-1 shows that ½ of this national monument is within the air quality boundary considered by the DEIS. In addition the Monument has over 700,000 visitors a year that should be considered in addressing the impacts on Recreation Resources and Social Conditions. When addressing Economic Conditions the DEIS considered benefits for Kane County, Kanab, Orderville and other communities within 50 miles of the Parcel's boundaries. Communities along primary haul roads such as Kayenta, Arizona were also included but impacts on the recreational traffic along several miles of Highway 89 within GSENM were not considered or even mentioned.	The FEIS has been revised in Section 4.15 to clarify the Recreation Resources Study Area. The potential impacts to recreation users of Grand Canyon–Parashant National Monument have been included in the FEIS in Section 4.16.2, Stakeholder Values. In addition, the potential impacts to adjacent federal lands are discussed in Section 4.14.3, Wilderness Characteristics.
AZ State Senate	213915	2	The cleanup from the last round of uranium mining is a long way from being completed and yet we are being asked to consider opening the area to another generation of uranium mining. This seems unnaturally short-sighted as any new uranium mining will further expose the Native populations of northern Arizona and southern Utah to more uranium contamination through the transportation of ore to the mill site in Blanding,	The proposed action (see Chapter 2) is not to open the project area to mining; this area was already open to mining prior to the Secretary of Interior's announcement of the proposed withdrawal, which segregated the lands until July 20, 2011. The decision to be made, informed by the analysis in the EIS, is

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Utah.	whether or not to withdraw, for up to 20 years, some or all of the area from location and entry.
Arizona House of Representatives	213921	2	The DEIS is deficient when it fails to take into account the legacy of harm and cumulative impacts caused by past uranium activities near Navajo communities in its assessment of environmental injustice impacts (DEIS, p. 4-239). It concludes that "there are other non-environment justice communities within the study area that could be exposed to the same health risks; therefore, these effects are not expected to be disproportionate to tribal environmental justice communities." Non-tribal communities, such as St. George, Ordervill, and Hildale cited in the DEIS, and non-environmental justice communities have been unaffected by several decades of uranium mining that occurred on Navajo lands, beginning in the 1950s. Unlike Navajo communities, that are not currently suffering from the pre-existing cumulative impacts of past uranium activities. Navajo people will therefore be disproportionally affected by the cumulative impacts of new uranium mining. The National Environmental Policy Act requires the consideration of "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency undertakes such other activities" [40 CFR 1508.7]	The Environmental Justice discussions in the FEIS in Sections 3.16 and 4.16 have been updated based on new information provided by the public and using a more refined methodology. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in “Stakeholder Values.” The discussion of potential impacts to non-environmental justice communities complies with legal requirements and Executive Order 12898 requiring environmental justice analysis. The revised environmental justice analysis thoroughly addresses cumulative impacts to the Navajo Tribe and other low-income or minority communities in or near the area proposed for withdrawal as required by law and the Executive Order.
Donna Brown	225253	8	Increasing mining claims could result in increasing numbers of uranium mines, and how those mines and the associated roads and utility lines could begin to "industrialize" one of the most remote and beautiful areas in the Southwest - the Arizona Strip. These increased developments would cumulatively increase habitat fragmentation and potential road kills from greater ore truck traffic. I realize that it may be more difficult to quantify these types of impacts, either because there is not comprehensive data on how the relevant native species may respond to this level of change, or the impacts are more subjective in terms of determining when remoteness is replaced by a number of more intensive land uses.	The number of mining claims has little bearing on the number of mines that may eventually be developed. Appendix B, the Reasonable Foreseeable Development scenarios, provides a projection of the reasonable projected mine development under each alternative in the EIS. The EIS uses the best available information and historic data to provide assumptions for the reasonably foreseeable development scenario described in Chapter 4 and Appendix B of the EIS. This information is used to provide a prediction of the level and type of reasonably foreseeable future locatable mineral exploration and development that could occur in the proposed withdrawal area.
Uranium Watch	225262	10	A major flaw in the DEIS is the failure to evaluate the impacts of the processing of the uranium ore at the White Mesa Mill, San Juan County, Utah, or even consider that the tailings from the processing of the ore will have to be under government control in perpetuity. The impacts from the dispersion of those tailings when the government is no longer able to provide long-term care have not been addressed.	Since operation of the White Mesa Mill will not change outside current permitted operations, the operation of the White Mesa Mill is out of the scope of this EIS. This EIS focuses on the direct or indirect changes to the human and physical/natural environment in and around the proposed withdrawal area.
Uranium Watch	225262	11	The DEIS provides a partial and inadequate assessment of the cumulative impacts from the historic uranium mining in the withdrawal area. The DEIS must fully assess the current impacts from historic uranium mining operations in the withdrawal area.	Chapter 3 of the DEIS describes the affected environment, with a focus on the existing resources and uses that could be affected by the Proposed Action and alternatives. This chapter takes into

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				account the historic uranium mining that has occurred in the project area. The cumulative impacts sections in Chapter 4 also take this historic impact into account. Appendix B provides additional historic background information for the withdrawal area.
Pew Environment Group	225274	2	While individual breccia pipe mines may have relatively small footprints compared to traditional open pit mines, the Department and its DEIS should consider, not only the possible impacts of individual mines, but also the broader impacts of turning the three proposed withdrawal areas into full-fledged mining districts. In our view, the DEIS does not deal appropriately with these potential cumulative impacts or with the discussion and evaluation of possible worst-case scenarios.	It must be emphasized that the proposed action is to withdraw the lands for up to 20 years from mineral location and entry, rather than to “turn the three proposed withdrawal areas into…mining districts.” Appendix B contains a description of the reasonably foreseeable development scenarios and provides the rationale for these scenarios. The EIS discloses potential cumulative impacts in each section of Chapter 4 using the best available information to evaluate reasonably foreseeable impacts to the human environment. In addition, NEPA does not require development of worst-case scenario. The worst case analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618 (Apr. 25, 1986). CEQ Regulations require analysis of reasonably foreseeable impacts, not worst-case scenarios.
Pew Environment Group	225274	12	In addition, the DEIS fails to consider a scenario in which a mine operation initially focused on a seemingly isolated ore body opts to move operations beyond that initial discovery. As the Department knows, this is a common mining practice, particularly on federal lands where the modest claimstaking requirements make it relatively inexpensive to pursue additional exploration in areas adjacent to an operating mine. The impacts of such expanded activity are apparent at the Bingham Canyon mine in Utah, in Butte, Montana, across the Carlin Trend of Nevada and elsewhere. Indeed, that potential arose at the Grand Canyon itself, when operators of the Orphan Mine in the 1960s pressed for authority to follow an ore discovery on claims then outside of the Grand Canyon National Park into the Park itself. Such scenarios, common to hardrock operations, are not accounted for in the DEIS, but could easily develop given the volatility of metals prices and the common practices of the hardrock mining industry. They would result in longer-lived and larger operations than those considered in the DEIS, greater levels of water usage and possible pumping over longer periods of time, as well as additional opportunities for waste materials to be spread through the environment. The cumulative impacts of these scenarios should have been considered in the DEIS.	Appendix B contains a description of the reasonably foreseeable development scenarios and provides the rationale and purpose for this scenario. Many experts in the BLM, USGS, Forest Service, other federal and state agencies, as well as individuals in the mining industry, were consulted in development of the RFD. Review of the geological conditions of breccia pipe ore deposits as described in USGS SIR 2010-5025 demonstrate that mine expansion as described in the comment are highly unlikely. However, should other breccia pipes be discovered in close proximity to ones being exploited by a mine both BLM and Forest Service require analysis under NEPA before approving any proposed mining operations —including proposed expansions of existing operations— which would be required to include its own cumulative effects analysis.
Pew	225274	15	Another assumption regarding the likely extent of mining activity deserves	Based on currently expected mining development as

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Environment Group			reconsideration. For purposes of the DEIS, the Department assumes that no milling would take place in the segregation areas themselves. It assumes that the current industry plans to haul ores to the existing uranium mill in Blanding, Utah would remain unchanged, regardless of the level of actual mining activity, the price of uranium or the price of oil. We agree that this is a possibility, but disagree strongly that it represents the only foreseeable scenario. Depending upon the price of uranium and future discoveries in what USGS describes as thousands of possible breccias pipes in the area, a much larger amount of uranium ore could be mined than that arbitrarily predicted in the DEIS. If extensive mining were to occur at the same time that oil prices rose, the cost of ore hauling operations or competition for access to the Blanding mill from additional mines in Utah could drive the economics of a Grand Canyon regional uranium mill. Failure to evaluate such a scenario seriously underestimates the deleterious impacts that could result, impacting the Park and its visitation, the Colorado River and the critically important deep R-aquifer. The risks associated with milling and mill tailings disposal are substantial, particularly in an area subject to relatively high winds and frequent flash flooding. Any tailings disposal facility would have to be carefully managed, not only through its operational life, but for decades to come. Under the Uranium Mill Tailings Radiation Control Act, this area would present a long-term radiation hazard and be permanently off limits to any activities or visitation. Such a use would clearly be incompatible with the natural resource protection goals of the broader area and the recreation use of the Park, the nearby Monuments and the nearby wilderness areas.	expressed by EIS Appendix B, Reasonable Foreseeable Development, there is no reasonable foreseeable milling operations within the project area. Because of industry input, the RFD assumes that the existing mill in Blanding, Utah, will continue to operate adequately and handle regional processing, and that no new uranium processing facilities will be constructed. Any proposed future milling operations on federal lands would be subject to site-specific NEPA analysis and regulatory permitting.
Mary Crow Costello	242652	3	Examining the DEIS, it appears that a thorough job of identifying environmental impacts was done. However, estimating the cumulative damage of multiple mines would be problematic and under-estimated as the complexities of many ecological processes are unknown to us. How will the BLM address cumulative impacts if there is no withdrawal, or a limited withdrawal?	Each resource section in Chapter 4 of the EIS discusses and analyzes potential cumulative impacts based on potential development scenarios defined in Appendix B, Reasonably Foreseeable Development Scenarios.
NEPA: Procedural Violation				
The NAU Project, LLC	242913	2	Based on the fact that opinion comments will be considered to in the decision making process and the fact that based on these comments, the BLM will identify a preferred alternative in the final EIS, how can anyone not conclude that this is voting and that the voting will determine the preferred alternative for the Final EIS. One other note, the BLM is the lead agency for the EIS and therefore the person responsible is the lead agency's official with line responsibility for preparing the EIS and assuring its adequacy is responsible for identifying the agency's preferred alternative(s). Are you saying the Secretary of the Interior is the BLM's official with line responsibility for preparing the EIS? I can see that the	The Dear Reader letter, the second project newsletter (February 2011) announcing availability of the Draft EIS, and the "Fact Sheet" that was handed out to everyone who signed in at the four public meetings each explicitly state that BLM is seeking substantive, meaningful comments rather than simple statements of opinion. All three documents include descriptions of the specific criteria for what is considered a substantive comment. In addition, the fact that BLM was seeking substantive comments rather than opinion was

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Secretary is the decision maker, but it seems that he is violating the NEPA process to interject himself at the lead agency level.	reiterated by BLM representatives during their introductory remarks at each of the public meetings. Although substantive comments are more helpful for NEPA purposes, all comments submitted were entered into the record and were made available for the Secretary of Interior to consider in making his decision, properly providing an opportunity for the public to voice their opinions under the public involvement requirements of FLPMA's withdrawal provisions and BLM's implementing regulations. By law, the Secretary of the Interior is the federal official authorized to make, modify, extend, or revoke withdrawals of public land (Section 204, Federal Land Policy Management Act of 1976, 43 USC 1714(a)). In that capacity, it is also his privileged to select the preferred alternative of the EIS.
Adam Whitman	58875	1	You are attempting to blanket remove a huge area from potential envelopment via a blanket use of NEPA. This is in place of allowing for exploration claims and permitting to take place with site-specific NEPA analysis that considers in-depth and real impacts instead of wild speculation based on an exponentially greater number of "what-ifs" when compared to a project development NEPA analysis.	The Secretary of the Interior is authorized to make, modify, extend, or revoke withdrawals of public land (Section 204, Federal Land Policy Management Act of 1976, 43 USC 1714(a)). The purpose and need for this particular action is identified in EIS Chapter 1, Section 1.3
Donald Begalke	225254	1	First scoping results are greatly insufficient in this Draft! From 83,525 scoping comments, only light generalities are in this Draft. Of all prior draft EISs, varied federal projects over years, scoping statements have always been included in drafts. However, the very voluminous scoping submissions inform that comments require alternate presentation in order for the reader to acquire assessment bases, and subsequently to present his/her comments on this Draft.	Only brief summaries of issues identified during scoping were presented in Section 1.5.1 of the DEIS. This section has been amended in the FEIS to state that a separate, 98-page Scoping Report was produced in March 2010 and posted to the BLM project website.
American Clean Energy Resources Trust (ACERT)	225256	2	The DEIS violates NEPA by not disclosing the preferred alternative or the 'proposed action.' While BLM proposes to withdraw all of the 993,549 acres of public land and National Forest System land from mining, the DEIS does not actually define the 'proposed action' as the preferred alternative. NEPA does not allow the federal agency to sit on the fence and leave the public guessing as to what is in fact the proposed action and what those impacts are likely to be. As the Supreme Court has stated on several occasions: Section 101 of NEPA declares a broad national commitment to protecting and promoting environmental quality. 83 Stat. 852, 42 U. S. C. § 4331. To ensure that this commitment is "infused into the ongoing programs and actions of the Federal Government, the act also establishes some important 'action-forcing' procedures." 115 Congo Rec. 40416 (remarks of Sen. Jackson). See also S. Rep. No. 91 -296, p. 19 (1969); Andrus v. Sierra Club, 442 U. S. 347, 350 (1979); Kleppe v. Sierra	Department of the Interior NEPA Implementing Regulations, at 43 CFR 46.426(a), state: "Unless another law prohibits the expression of a preference, the draft environmental impact statement should identify the bureau's preferred alternative, if one or more exists." No preferred alternative existed at the time the Draft EIS was published. Both the Department of Interior Office of Environmental Policy and Compliance and the USDOI solicitor's office approved the Draft EIS publication without a Preferred Alternative. Agencies refrain from identifying a preferred alternative in the DEIS, both so as to avoid the appearance of a final decision having been made prior to the DEIS even being published, and because

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Club, 427 U. S. 390,409, and n. 18 (1976). Robertson v. Methow Valley Citizens Council, 390 U.S. 332, 348 (1990). The Council on Environmental Quality (CEQ) regulations that implement NEPA require that the preferred alternative, if different from the proposed action, be disclosed in the draft document 40 C.F.R. §1502.14(e). The BLM NEPA policy echoes this requirement. H-1790-1,9.2.6.1 (2008). Similarly, the DOI regulations require each bureau to clearly disclose the proposed action, which in this case, is the proposed withdrawal of all of the federal lands. Thus, there is no rational basis to not disclose the proposed action as the preferred alternative. The suggestion that BLM has not made up its mind is clearly disingenuous in light of the previous segregation of almost one million acres of federal land in 2009. The high political profile of the proposed action does not support the claims by the Departments that there is no preferred alternative.	they wish to elicit as much input from the public and other interested parties prior to actually deciding what their preferred alternative will be. See Question 4c, Council on Environmental Quality's Forty Most Asked Questions Concerning CEQ's NEPA Regulations. The Proposed action is clearly identified in the EIS in Chapter 1, Section 1.1.
National Mining Association	225281	5	Comments submitted by NMA during the scoping period prior to development of the DEIS, requested the department identify specific deficiencies with the existing land use planning process to explain why the process was insufficient to protect GCNP resources from the impacts of mining. Receipt of this and similar comments is noted in the BLM March 2010 Proposed Withdrawal Scoping Report, "BLM is ignoring its 5-year effort to revise its management plan, which would have kept much of the land in question open for mining activities." Scoping Report, p.43. One purpose of scoping is to identify issues and concerns to be considered in the environmental impact statement. Yet the DEIS fails to provide any discussion of the Resource Management Plan (RMP) developed by BLM that covered much of the land within the proposed withdrawal.	DEIS Chapter 1, Section 1.4.1, page 1-5 states: "In accordance with FLPMA, the Arizona Strip Field Office RMP allows for sustainable multiple uses of public lands. If a withdrawal alternative is implemented, the RMP will be updated if necessary." The Arizona Strip RMP (February 2008) is not yet due for the five-year evaluation; the analysis provided in this EIS will help inform that review.
Quaterra Resources, Inc.	242664	9	Section 204 of the Federal Land Policy Act of 1976 requires "a legal description of the entire land area that falls within the exterior boundaries of the affected area." While the DEIS states in several sections that the lands were identified by "legal description" in the Federal Register notice of July 21, 2009, this notice simply listed the townships that were included in the proposed withdrawal, which does not constitute a legal description. Had legal descriptions been provided, a comparison of active claim boundaries with the proposed withdrawal area could have been properly conducted.	Legal descriptions of all parcels proposed for withdrawal under each of the alternatives have been included as Appendix C to the FEIS.
Frank Bain	242677	1	My first comment has to do with the favoritism that is obviously being granted to Native American Tribes whose reservations are near the proposed withdrawal area. After attending the public meeting in Flagstaff where the Draft EIS was presented by personnel from various state and federal agencies, the elders of the Havasupai Tribe were given time to address the audience and present their point of view regarding uranium exploration on non tribal land. The Havasupai and other tribes are sovereign nations so why is the federal government giving preference to their opinions. The average citizen, environmental group, mining claim	The decision to allow the Havasupai elders to speak was consistent with long-standing BLM policy to encourage cooperation and mutual respect between U.S. Government agencies and sovereign Tribal governments. It was also an acknowledgement of the very substantial time and effort required for the Havasupai to leave their reservation and travel to and from the meeting in Flagstaff.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			owner, or uranium mining company was not afforded this same opportunity to address the audience. Why not?	
Garfield County	246167	5	The socioeconomic analysis of the EIS is lacking any perspective, depth and/or specificity. Local governments in the area have jurisdiction and expertise over socioeconomics, custom, culture and the human environment. Yet, it appears that no local government was offered cooperating agency status and the federal agencies prepared the document without any significant input from potential cooperating agencies and/or joint lead agencies. Did the BLM offer cooperating agency or joint lead agency status to any level of local government and if so what level? Were cooperating / joint lead agencies able to be involved in the development of the EIS in accordance with the NEPA, CEQ regulations and FLPMA?	Details of the Public Participation Process, including the participation of Cooperating Agencies, is described in Chapter 1, Section 1.4.2, and in Chapter 5, Section 5.2. The project spans a million acres and two Arizona counties, which limits the level of specificity the EIS can address pertaining to any potential resource impact. Since the analysis is not specific to a particular mining proposal, but rather the possible change in mining activity due to the proposed withdrawal and alternatives across the entire area, the specificity of the economic analysis is necessarily high level. In the early stages of the project, letters were sent to the state and local governments and agencies inviting them to participate as Cooperating Agencies. That list was developed based on anticipated impacts from the proposed action, since no actual impact analysis was completed at that time. As a result of those invitations, Cooperating Agency Memoranda of Understanding were developed and signed with Mohave and Coconino Counties in Arizona, Washington, Kane and San Juan Counties in Utah. Recently, Garfield County Utah requested Cooperating Agency status and a Memorandum of Understanding was signed with them as well. Throughout the EIS process, Cooperating Agencies have participated in the project. Four Cooperating Agency meetings have been held at various points in the EIS process, and all Cooperating Agencies have had access to a project Data Share site where draft versions of all project documents have been made available for review and comment before being released to the public. Monthly teleconference calls have been held with Cooperating Agencies throughout the EIS process to keep cooperators informed and to continue to provide an opportunity for input. Finally, all cooperators have had an opportunity to contribute to the project based on their legal jurisdiction or special expertise as identified in their signed Cooperating Agency Memorandum of Understanding.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Reasonably Foreseeable Development Scenarios				
Karen & Robert Cizek	104116	1	If any mining is done in this area (and thus impacts the U.S. Environment) the mineral should be used in the U.S., not sold abroad. Is this addressed in the report? Is there any legal presedent to do this?	This issue is addressed in the FEIS; see Section 4.17.2, Energy Resources.
Karen & Robert Cizek	104116	2	Is there some place else in the U.S. where uranium and other minerals could be obtained with less risk to the environment and less risk to cultural resources? Is this address in the report? If not, it should be.	The purpose of this EIS is to analyze the impacts of the Proposed Action and alternatives, which is a withdrawal from the mining law of 1872 of approximately 1 million acres in Northern Arizona and two reduced withdrawal alternatives. Comparison of impacts with mining in other areas isn't relevant to the analysis in this EIS.
Donald Begalke	225254	12	In uranium-mining operations, can used water be recycled to continue mining operations?	The reuse of water is an operational concern that would be assessed on a site-specific basis. In terms of the calculations used in the FEIS, 60% of the water is consumed for dust control and is not available for recycling. The remaining 40% is used for drilling operations and sanitation, and is not likely to be recycled either. For the purposes of estimating impacts from water use, the FEIS assumes that no recycling will occur.
DIR Exploration, Inc.	225241	4	The general and specific assessments of uranium resource potential do not take into account a geologically-obvious structural control of the distribution of economically-mineralized uranium-bearing breccia pipes in northern Arizona. Resource estimates qualified by recognition of this clear control of the location of economic breccia pipe uranium mineralization show that the proposed withdrawal of about 1,000,000 acres of northern Arizona will not result in a small 12% decrease of the Arizona uranium resource availability, but will instead result in a much larger (6x) 76% decrease in availability of this particular domestic energy resource.	The full comment letter questions the approach of assigning mineral potential to regions of Northern Arizona that was used in the 2010 USGS estimate of uranium availability, and concludes that the preferential presence of breccia pipe mineralization on the proposed withdrawal lands is not properly incorporated into the estimates of uranium availability. While the commenter provided a statistical correlation of known mineralized breccia pipes to underlying geologic structures, no geologic explanation or new information was provided to justify the hypothesis that mineralized breccia pipes occur preferentially on the proposed withdrawal lands. The USGS Report is a peer-reviewed publication that provided the estimated uranium endowment for the proposed withdrawal area. While some commenters have presented alternate or supplemental approaches to assessing the uranium endowment from that

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				provided by USGS, these alternate approaches have not been developed or peer reviewed to the extent that they can replace or supersede the USGS endowment assessment presented in SIR 2010-5025. As with many scientific fields, new information is constantly being collected which leads to new or refined conclusions. However, at present, the USGS Report contains the best credible information available regarding the uranium endowment estimate and was therefore used as the basis for the reasonably foreseeable development scenarios in the EIS. No change is warranted to the 2010 USGS estimate of uranium availability, or the use of this estimate in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	126	LOCATABLE MINERAL RESOURCES - REASONABLY FORESEEABLE DEVELOPMENT SCENARIOS *Statement: Entire Chapter* Comment: The following comment is just a small portion of Mr. Gene Spiering's comments. Mr. Spiering is an expert on breccia pipe uranium mining in northern Arizona. He is also Vice President of Quaterra Resources and member of ACERT. His entire comment letter is attached to our comments for your reference. "Unlike any other known uranium districts in the world, a cross section through the center of the district is visible in the walls of the Grand Canyon. Nearly all the known mineralized pipes and all of the economically viable uranium deposits in the region have been found in a N-S trending mineralized "corridor" that is approximately 45 miles wide by 110 miles long. The hundreds of pipes mapped outside of this corridor are barren. All of the proposed withdrawal area is within this corridor because the area was selected by drawing a line around the focus of the claim staking activity. Most of the remaining corridor has already been withdrawn from mineral entry. Any proposed withdrawal but alternative "A" (no action) will destroy the potential development of the district for 20 years and probably forever."	As with the comment from DIR (225241:4), the commenter suggests that mineralized breccia pipes occur preferentially within the proposed withdrawal lands, including a reference to a large number of non-mineralized pipes drilled outside of the proposed withdrawal area. However, no geologic explanation or new information was provided to justify the hypothesis that mineralized breccia pipes occur preferentially on the proposed withdrawal lands. The USGS Report is a peer-reviewed publication that provided the estimated uranium endowment for the proposed withdrawal area. While some commenters have presented alternate or supplemental approaches to assessing the uranium endowment from that provided by USGS, these alternate approaches have not been developed or peer reviewed to the extent that they can replace or supersede the USGS endowment assessment presented in SIR 2010-5025. As with many scientific fields, new information is constantly being collected which leads to new or refined conclusions. However, at present, the USGS Report contains the best credible information available regarding the uranium endowment estimate and was therefore used as the basis for the reasonably foreseeable development scenarios in the EIS. No change is warranted to the 2010 USGS estimate of uranium availability, or the use of this estimate in the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
American Clean Energy Resources Trust (ACERT)	225256	127 & 128	Pages 8-24 thru 8-27 Comment: The EIS says that there is slightly over 49 million pounds of economically mineable uranium in the proposed withdrawal area. This is based on the assumption that there is a 327 million pound endowment in the withdrawal area, and 15% of the endowment is mineable. This is totally inaccurate and greatly understates the amount of mineable uranium in the proposed withdrawal area. This is one of the most serious errors in the EIS, as it greatly understates the impact of the proposed withdrawal and affects the calculations in many other sections. …Figure 1 below shows that 77% of the 44 pipes drilled in the North and South withdrawal areas have been found to contain uranium in concentrations sufficient to be considered for a mine. Of this number 16 (36%) are confirmed orebodies, and another 18 (41 %) are mineralized but need more drilling to establish whether or not they are economically mineable, thus 77% are definite or possible economically mineable orebodies. *see submittal #225256 for detailed figure information.	The USGS prepared an analysis of the uranium “endowment” in the proposed withdrawal area; “endowment” refers to ore with over 0.01% grade uranium. However, only a percentage of this uranium endowment is considered economically mineable; the assumption in the FEIS is that 15% of the uranium endowment would be economically mineable. This comment questions the use of this percentage In order to facilitate the impact analysis we need to be able to differentiate between mineralized deposits and economically mineable deposits. To this end, we identified available data and literature, and interviewed agency, academic and industry experts. It became readily apparent that the information needed to make a precise calculation is not available. As such we used the information that is available, including the sole available literature reference (Weinrich and Sutphin 1988), analysis of the ore grades planned to be mined in known breccia pipes, and general success rates for mining exploration, and made the assumption that 15% of mineralized deposits would be economic to mine. We received several comments on the 15% assumption, including alternative approaches. We considered these comments and evaluated the proposed alternatives to determine if they proved to be any more viable than the approach we took. In the end, we concluded that there are just too many unknowns with the data set we have on known breccia pipes in the area to allow for an exact calculation of the portion of the endowment that would be economic to mine.
American Clean Energy Resources Trust (ACERT)	225256		Based on mapping in the Grand Canyon (Wenrich and Sutphin, 1988) it can be seen that approximately 33 pipes per 100 square miles occur at the Redwall and lower Supai horizons where these formations outcrop in the Grand Canyon. It can be assumed that the density of pipes is the same under the flat country north and south of the Grand Canyon as it is in the Canyon. Not all pipes penetrate to the upper Kaibab Formation or lower Moenkopi which are the dominant formations in the flat country on either side of the Grand Canyon. Some pipes have ceased to collapse before reaching this horizon and do not outcrop. By plotting the number of pipes which outcrop at the various stratigraphic horizons from the Redwall to the Chinle formations it can be shown that there are approximately 12 pipes per 100 square miles at the lower Toroweap horizon. It is thought that a pipe must penetrate at least to the lower Toroweap Formation to be mineralized because the Coconino Sandstone may act as the conduit for	This comment offers an alternative method for calculating the uranium endowment. The proposed technique is both valid and fundamentally different from the technique used by the USGS to estimate the uranium endowment. However, there is no obvious merit or improvement over the technique used by the USGS. The USGS Report is a peer-reviewed publication that provided the estimated uranium endowment for the proposed withdrawal area. While some commenters have presented alternate or supplemental approaches to assessing the uranium endowment from that provided by USGS, these alternate approaches have

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			mineralizing solutions and the Toroweap furnishes reductant. Using the numbers given in the EIS the North and South proposed withdrawal areas comprise an area of 1369 square miles. With 12 pipes per 100 square miles this area is estimated to contain 164 breccia pipes. If 50% of the pipes contain orebodies there would be 82 orebodies in the North and South withdrawal areas, containing 246 million pounds of uranium, assuming 3 million pounds per orebody, which has been the average to date. If 60% of the pipes contain orebodies there would be 98 orebodies containing 294 million pounds of uranium. These numbers are 5-6 times the amount of uranium estimated in the EIS. It is important that the EIS be corrected to reflect the above numbers. Numbers in other sections the EIS need to be recalculated to reflect the above numbers with respect to direct and peripheral jobs created, tax revenue generated, income generated, and other benefits at the local, state and federal levels.	not been developed or peer reviewed to the extent that they can replace or supersede the USGS endowment assessment presented in SIR 2010-5025. As with many scientific fields, new information is constantly being collected which leads to new or refined conclusions. However, at present, the USGS Report contains the best credible information available regarding the uranium endowment estimate and was therefore used as the basis for the reasonably foreseeable development scenarios in the EIS.
American Clean Energy Resources Trust (ACERT)	225256	129	Page 8-25, Table B-4 Comment: The amount of U30 a in the Arizona Strip area as estimated by the US Geological Survey is 163,380 tons, (326.76 million pounds) (see Table 3.3-1, page 3-35 and Appendix B, Table B-4, page B-25). Yet when making statements as regards the total amount of U30 a in the country the DEIS uses the 2003 values from the EIA of 123 million pounds in Arizona, Colorado, and Utah combined (see Table 3.16-20, page 3-275). This leads to the conclusion that the amount of resource in Arizona is not significant with regard to the entire country. This is a serious discrepancy and needs correction and resolution, because it is often quoted in the media (and in economic analyses) without the background mentioned above.	This comment misunderstands the USGS endowment estimate. The entire USGS endowment is not economically mineable, only a portion of it is. Section 3.3 of the FEIS has been changed to reflect updated numbers from the EIA
Energy Fuels Resources	225260	13	The assumed scenario of 18 new mines coming into production over the next 20 years in addition to the three existing ones is extremely optimistic and probably represents the maximum number of mines that could possibly be found, permitted and put into production during that time frame if exploration was very successful. A more likely number would be 10 (one every two years). Based on my past experience during the 1980's and 1990's there was extensive exploration carried out by numerous companies. Energy Fuels Nuclear Inc had an aggressive exploration program as did Rocky Mountain Energy, Pathfinder Mines, Uranerz and others. During the ten year period from 1982 to 1992 only five new deposits were located (Hack Canyon and the Canyon pipes were discovered in the 1970's) and developed into mines and two of the five were readily visible from adjacent canyons. Therefore, the easy-to-find deposits in the area have already been found and it is unlikely that future exploration will be as successful as past exploration even with improved exploration techniques. Furthermore, the time to permit a new mine on public land in the U.S. now averages about 7 years starting with baseline studies and mine design, continuing through development of a plan of operations, and culminating with state permit applications and the NEPA	The difficulty finding breccia pipes as described in the comment is not consistent with changes and improvements in technology described by industry. These improvements suggest that in the future exploration for pipes will not rely on exposure or visibility, but rather on remote sensing techniques. Exploration success is not expected to be a limiting factor in breccia pipe development. With respect to development time frames, these times took into account viewpoints from RFD team members, regulators, geologists, and industry representatives, and are considered reasonable.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			analysis.	
Energy Fuels Resources	225260	14	Under Bullet 2, of the 45 confirmed breccia pipes noted for potential future mining activity, many of these pipes have been thoroughly explored and don't have sufficient resources to justify mining operations now or in the future. In addition, several of the breccia pipes on the list that are classified as undetermined have sufficient exploration to remove them from the list since they are not breccia pipes. Therefore, based on my knowledge of most of the pipes on this list, this list should be reduced by at least 12, a reduction of over 26%.	All breccia pipes listed in Table B-3 have been “drill confirmed”. A breccia pipe is considered "drill confirmed" when one or more holes have identified breccia or mineralization in or below the lower Toroweap horizon. Insufficient information is provided by the comment to contradict the previous information provided in Appendix B, Table B-3.
Energy Fuels Resources	225260	15	[section 4.1.1] The 7-year mine life listed under Bullet 4 appears to be based on historic information. Currently, permitting and planning is typically much longer than two years for a new mine. There is insu'fficient milling capacity at the White Mesa Mill to process full production (assumed at 300 tons per day) from six mines on the Arizona Strip. Because of the relatively high grade of the ore, the precipitation and packaging portion of the mill can probably only handle 1,000 tpd over a 350 day work year and that would assume that all of the mill's ore was coming from the Strip and none from existing mine operations in Utah and Colorado.	With respect to development time frames, these times took into account viewpoints from RFD team members, regulators, geologists, and industry representatives, and are considered reasonable.
Energy Fuels Resources	225260	16	Assuming a maximum number of mines (i.e., 6) at a relatively high average production rate (i.e., 300 tpd) results in an over-calculation of impacts including the truck haulage numbers. While I do not object to making these assumptions, the text should state that the numbers represent a maximum potential impact.	The haul numbers were based on proposed plans of operation for the EZ-1/EZ-2/What breccia pipes (Denison 2010a) and are considered realistic representations of expected conditions.
Energy Fuels Resources	225260	17	Under Bullet 8, making the assumption that each mine would drill a production well into the R-aquifer is not a correct assumption. These wells are deep and expensive and several of the mines on the list that will be developed and mined are clustered (i.e. EZ 1, EZ2 and the What and Findlay Tank NW and SE) where only a single well would be drilled for the clustered pipes. It is also highly likely that breccia pipes near a facility with a deep well, if developed, would truck water from an existing well rather than take the risk and go to the expense of drilling and developing a new well. Also, the amount of water assumed to be used by each mine is exaggerated due to the fact that each breccia pipe has some perched water that is contained in the mine and can be used for mining operations.	The number of production wells does not actually enter into any calculation or impact analysis; rather, the total water use of the mines is used to estimate impacts and this will not change whether the water is withdrawn on site or nearby. It is recognized that some dewatering could occur in mines associated with perched aquifers, but given that not all mines would encounter perched aquifers, a more conservative approach was selected for the RFD to assume water needs for dust control, sanitation, and drilling would be pumped from deep supply wells.
Uranium Watch	225262	13	This section states that there are six (6) new uranium mines likely to occur in the South Parcel. However, in the discussion of Alternate B (page 2-14), it states: *In the South Parcel, there is one partially developed mine, the Canyon Mine, but there are no other breccia pipes with estimated uranium resources.* If there are no other breccia pipes with estimated uranium resources with estimated uranium resources in the South Parcel, there does not appear to be any basis for the estimated 6 new uranium mines in the next 20 years. The EIS should provide a factual basis for the	Breccia pipes with estimated uranium resources from only a portion of the reasonably foreseeable development scenario. To be complete, the RFD needs to account for potential future exploration and discoveries. As shown in Table B-7 of Appendix B in the FEIS, in addition to the one known pipe with uranium (the Canyon mine), of the 6 new uranium mines, one is estimated to arise from known

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			estimation of 6 new mines in the South Parcel under Alternative A.	mineralized breccia pipes, and 5 are estimated to arise from as-of-yet undiscovered breccia pipes. These new mines are undiscovered, but their potential to be discovered and mined are estimated based on appropriate probabilities.
Uranium Watch	225262	23	Section 4.1.1 Foreseeable Activity Assumptions. Pages 4-1 to 4-2. This section assumes a life cycle of a mine to be 7 years. However, there are existing uranium mines in the withdrawal area that have been on stand-by for a time period much longer than 7 years. There is no basis for the assumption that waste rock and other sources of radioactive and non-radioactive contamination will remain on the surface for a period of time less than 7 years. Therefore, the EIS should include a full assessment of the impacts to the environment of uranium mining operations for periods of time that exceed 7 years. The 7-year life cycle was determined from a review of existing and recent locatable mining activity. The DEIS does not include data and information about existing uranium mining operations and their life cycles or the life cycle of previous uranium mining operations in the withdrawal area. The data and information on the life cycle of past and current uranium mining operations in the withdrawal area that formed a basis for the 7- year life cycle estimate should be included in the EIS.	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim management.
Uranium Watch	225262	24	Section 4.1.1 Foreseeable Activity Assumptions. Pages 4-1 to 4-2. The DEIS assumes that waste rock will be backfilled into the mine. The DEIS does not provide a basis for the assumption that all waste rock and other contaminated materials will be backfilled into the mine. It is possible, under BLM and USFS regulations, to have waste rock and other sources of contamination remain on the surface. Unless there is a legal requirement for all waste rock and other deleterious material at the uranium mines to be placed back in the mines, the EIS must assume that those materials will remain on the surface and evaluate the environmental impacts of those surface materials over the short and long term.	The assumption that waste rock will be backfilled into the mine is taken from the proposed plan of operation for the EZ-1/EZ-2/What mine (Denison 2010) and is considered a realistic representation of expected conditions. A reference has been added to the FEIS in Section B.4.5, Appendix B, to identify the source of this assumption.
Uranium Watch	225262	26	Section 4.1.1 Foreseeable Activity Assumptions. Pages 4-1 to 4-2. What is the basis for the assumption that the disturbance from exploration drilling will be temporary? At what point is an area that has been "disturbed" no longer considered to be "disturbed"?	Surface disturbance associated with exploration is temporary. Once exploration is completed the area is reclaimed in accordance with the reclamation plan; the drill holes are plugged and the drill site is reshaped, where necessary, and then seeded. This usually occurs within the same field season as the drilling activity. Upon completion of the revegetation requirements the reclamation financial guarantee is released and the area is considered reclaimed, i.e., no longer “disturbed.” For mine development and mining, the surface disturbance is longer term, although the reclamation process is similar to that describe for exploration. A

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				reclamation plan is developed in advance of any surface disturbance along with a reclamation cost estimate. As mine operations come to conclusion the mine equipment and facilities are removed, the area is reshaped, the openings are plugged and sealed, and the disturbance area is reshaped to approximate pre-disturbance contours. The area is seeded with a pre approved seed mix. After a couple of growing seasons the revegetation is assessed to determine whether it meets the success criteria. If so, the reclamation financial guarantee is released and the area is considered reclaimed, i.e., no longer "disturbed." For a mine site the disturbance can last 5-7 years depending upon the operating schedule. Should a mine go into standby mode under its interim management plan some interim reclamation may be required to stabilize the area but it would still be considered disturbed since final reclamation had not been implemented. Explanatory text has been added to the FEIS in Sections B.4.3 and B.4.4.
Uranium Watch	225262	28	Section 4.1.1 Foreseeable Activity Assumptions. Pages 4-1 to 4-2. The section on reasonably foreseeable developments assumes that a maximum of six mines would be in production at any given time. Given the assumption that a typical breccia pipe would produce 1,500 tons of U3O8 and would be productive for 3 years, the amount of U3O8 produced by 6 mines in a single year would be 3,000 tons. The White Mesa Mill is permitted in its license to produce 4,380 tons of yellowcake per year.[1] In addition to the existing (Arizona 1 Mine) and potential breccia pipe mines, the White Mesa Mill is currently receiving ore from the Pandora Mine, Beaver Shaft Mine, and Daneros Mine in Utah. Denison Mines (USA) Corporation also has at least 3 mines on standby (Tony M, Rim, and Sunday Mine Complex), there are at least 3 proposed mines in Utah that would supply ore to the mill, and there are additional proposed exploration projects in Utah. Therefore, given the limitation on the production of U3O8 at the White Mesa Mill and the operation of mines outside the withdrawal area that would provide ore to the mill, it is unlikely that the mill would support the production of ore from 6 mines per year in the withdrawal area over the next 20 years.	The RFD considers not just the capacity of the White Mesa Mill, but also the likelihood of additional mill capacity coming online in the region. For example, the White Mesa Mill capacity is, as stated, 4,380 tons per year. Pinon Ridge is expected to eventually handle 1,000 tons of ore per day, which could yield close to 2,000 tons of uranium per year. This brings the known mill capacity in the region to over 6,000 tons per year. Nor is this the only mill in consideration in the region. For instance, Strathmore Minerals Corporation is currently seeking permits for a mill to service the planned Roca Honda mine in New Mexico. Based on the estimated capacity and the estimated production, even given the current needs from existing mines, mill capacity was not considered to be a limitation. Industry representatives contacted indicated this opinion as well. The capacity of the White Mesa and Pinon Ridge mills has been further clarified in the FEIS in Appendix B, Section B.8.1.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Uranium Watch	225262	95	Appendix B fails to discuss the installation of ventilation shafts at uranium mines to provide fresh air and to reduce the amount of radon in the underground mines. The installation of vents results in surface impacts for access roads and the vent site.	Vent shafts were one of the mine features included within the mine site foot print for each mine in the RFD. For example, according to the proposed mine plan of operations for the EZ-1/EZ-2/What breccia pipes (Denison 2010), vent shafts would be located approximately 200 feet from the breccia pipes. This would place the vent shafts well within the expected 20-acre footprint of the mine.
Uranium Watch	225262	96	Appendix B overestimates the foreseeable future mineral development for Alternatives A, C, and D. Appendix B fails to consider the ownership of the mine site on the economic viability of a proposed mining operation. Denison Mines is the owner of the currently operating and proposed uranium mines in the withdrawal area. Denison Mines ships that ore to the White Mesa Mill, which they also own. Mine project that are owned by other companies must consider the financial arrangements with Denison Mines for the milling of ore. Currently, there is only one mine that is currently shipping ore to the White Mesa Mill that is not owned by Denison Mines: the Daneros Mine, San Juan County, Utah, owned by Utah Energy Corporation, a subsidiary of White Canyon Uranium LLC, an Australian company. Utah Energy Corporation is the same family that operates Denison Mines' Pandora Mine in La Sal, Utah. Therefore, there appears to be a special relationship between Denison Mines and the Utah Energy Corporation for the purchase of ore.	The RFD is based primarily upon the uranium resource capabilities of the area, mining technology available, and economic conditions. Relationships between corporate entities that may or may not be operating in the area were not determining factors in preparation of the RFD. The focus for analysis is on the potential mines and not any particular operator. Most mines considered in the RFD are based on as-of-yet undiscovered breccia pipes. The future ownership of these breccia pipes or mines is impossible to know. Nor is the ownership of mills in the area guaranteed to remain constant. For these reasons, the effect of the relationships between mine and mill owners is considered too speculative to be a determining factor used in preparation of the RFD.
Uranium Watch	225262	97	A major economic consideration associated with foreseeable development of breccia pipe mining operations by mining companies other than Denison Mines would not be the price of uranium. It would be the uranium ore purchase agreement or other financial agreement with Denison Mines or the owner of the Piñon Ridge Uranium Mill, should that mill be constructed. Therefore, it is possible that it would not be economical to mine confirmed mineralized breccia pipes. The EIS should also consider this aspect of the economic viability of uranium development in the withdrawal area.	The RFD is based primarily upon the uranium resource capabilities of the area, mining technology available, and economic conditions. Relationships between corporate entities that may or may not be operating in the area were not determining factors in preparation of the RFD. The focus for analysis is on the potential mines and not any particular operator. Most mines considered in the RFD are based on as-of-yet undiscovered breccia pipes. The future ownership of these breccia pipes or mines is impossible to know. Nor is the ownership of mills in the area guaranteed to remain constant. For these reasons, the effect of the relationships between mine and mill owners is considered too speculative to be a determining factor used in preparation of the RFD.
Uranium Watch	225262	98	The EIS must also consider the processing and tailings impoundment capacities of the White Mesa and Piñon Ridge Mill and the operation or development of uranium mines in other locations when considering foreseeable mine development in the DEIS area.	The processing or uranium and storage of tailings are beyond the scope of this EIS (see Chapter 1, Section 1.5.3, Issues Eliminated from Detailed Analysis). This section has been expanded in the FEIS to provide specific rationale for elimination from detailed analysis.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Uranium Watch	225262	99	The Tables in Appendix B that estimate the duration of temporary surface disturbance have no basis. The tables estimate temporary disturbance of 4 years for the mines and 1 month for the exploration drilling. This does not take into consideration the time it takes to reclaim the disturbed areas. The EIS must include a full evaluation of the time it has taken to restore roads, exploration drill sites, mine sites, power lines, ore storage areas, waste rock areas, vent hole sites, and other areas disturbed by historic uranium mining operations in the withdrawal area.	Explanatory text has been added to the FEIS in Sections B.4.3 and B.4.4 regarding the duration of temporary impacts, and the tables in Appendix B referencing the time period of 4 years will be modified to reflect reclamation. These include Tables B-14, B-16, B-22, B-24, B-31,B-33, B-40, and B-42.
Uranium Watch	225262	100	Appendix B does not take into consideration the duration of surface disturbance for the existing breccia pipe mines and the possible length of time that a mine may be temporarily suspended prior to the completion of reclamation.	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim management.
Uranium Watch	225262	101	Appendix B assumes that the waste rock will be returned to the mines and will not remain on the surface. The EIS must include the basis for that assumption.	The assumption that waste rock will be backfilled into the mine is taken from the proposed plan of operation for the EZ-1/EZ-2/What mine (Denison 2010) and is considered a realistic representation of expected conditions. A reference has been added to the FEIS in Section B.4.5, Appendix B, to identify the source of this assumption.
Uranium Watch	225262	102	Appendix B estimates the number of ore-haul trips, but does not provide the estimated mileage for those trips or the amount of fossil fuel that will be consumed. That data should be included in the EIS.	Given the unknown locations of as-of-yet undiscovered breccia pipes and the mills to which ore might be taken, estimating mileage is not possible. Estimates of emissions from hauling are included in Section 4.2 of the FEIS.
Uranium Watch	225262	103	Appendix B contains data on the estimated surface disturbance under the 20-year time frame. However, there is no data for the amount of land that will have been disturbed and will remain disturbed (not yet fully reclaimed) beyond 20 years. The EIS should include an evaluation of the amount of land estimated to still be disturbed after 20 years of mining activities under the various alternatives.	An underlying assumption in the RFD is that the life cycle of each mine would consist of 7 years, which includes a 1 year reclamation phase. Under this assumption, no permanent surface disturbance would persist following reclamation. While there indeed may be several mines that are in the middle of operations at the end of 20 years, surface disturbance at these mines would be expected to be fully reclaimed as well.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Uranium Watch	225262	104	Appendix B should include data on the industrial capacity to mill uranium at the White Mesa and the proposed Piñon Ridge Mill.	The capacity of the White Mesa and Pinon Ridge mills has been further clarified in Appendix B, Section B.8.1.
Uranium Watch	225262	105	Appendix B should include data on the quantity of uranium available to mine in other areas that could reasonably be expected to provide ore to the White Mesa Mill and the proposed Piñon Ridge Mill. The EIS must not give the impression that there are no other sources of uranium ore in the area of the existing and proposed uranium mills. Any current and proposed uranium mines that would supply ore to the White Mesa Mill and proposed Piñon Ridge Uranium Mill are related actions. There are currently 4 mines that supply ore to the White Mesa Mill, 3 of which are on BLM land. There are also 2 DUSA mines on standby that are on BLM land, and other foreseeable mining operations in the area that are on standby or in the permitting process.	The processing of uranium ore and related activities at the White Mesa Mill are beyond the scope of this EIS (see Chapter 1, Section 1.5.3, Issues Eliminated from Detailed Analysis). This section has been expanded in the FEIS to provide specific rationale for elimination from detailed analysis.
Arizona Mining Association	225266	8	Section 2.4.1, Section 4.3.5 and Section 4.3.6 The DEIS does not put into proper context the fact that considerable acreage of land has already been withdrawn in the vicinity of the proposed withdrawal area. As acknowledged in Sections 4.3.5 and 4.3.6 of the DEIS, 50% ofthe 9,100 square miles designated as high mineral potential for uranium in Northern Arizona has already been withdrawn from mineral location and entry. Under the Proposed Action, the land withdrawn would increase by 1,579 square miles to almost 70% of the land with high uranium potential. Furthermore, the withdrawal of 70% of lands with high uranium potential does not include large land blocks that various tribes have closed access to under uranium mining moratoriums. As noted in ARPA's comments, this region is one of the most important uranium-producing regions in the United States with nearly a 300-400 million pound uranium endowment according to the BLM and the USGS (Circular 1051). This endowment represents an enormous and vital domestic supply of clean energy at a time critical to the energy needs of the United States. The Proposed Action would require the nation to forego almost half of its uranium resources and force the country to become even more import dependent for this strategic mineral.	This information is considered in the FEIS in Table 4.3-3, which summarizes the percentages of cumulative land withdrawal for all alternatives. It is further described in the cumulative impacts portion of Sections 4.3.5 and 4.3.6.
Pew Environment Group	225274	11	The DEIS assumes that each new mine opened around the Grand Canyon would operate from permitting and development through mining and reclamation for a total of seven years. It also assumes that a maximum of six mines would operate at any one time. The basis for these assumptions reportedly comes from review of existing and recent mining activity in the area, and the sources cited are primarily uranium industry documents and communications. While it is true that at least two of the mines that operated in the area in the past fit the seven-year timeframe, we do not believe that information should be relied upon for predictions of future activity. In contrast to the assumptions in the DEIS, most hardrock mines, including other mines in the Grand Canyon area, have "operated" for much longer periods, not moving directly to final reclamation in less than a	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			decade, but frequently suspending operations or stockpiling low grade ores during times of low prices. In such instances, unreclaimed waste ore, overburden and lower grade ores may remain on the site and subject to the wind erosion or high-volume flash flooding which USGS notes is common to this area. As the USGS studies indicate, this has been the case for existing mines, including Kanab North and Arizona 1, both of which halted operations for nearly two decades before recently resuming production. To the extent that any new mines would encounter groundwater that might necessitate pumping, most likely in a perched aquifer formation, such pumping would likely continue during shut-down in order to keep the mine workings dry.	management.
Pew Environment Group	225274	13	In addition, the DEIS fails to consider a scenario in which a mine operation initially focused on a seemingly isolated ore body opts to move operations beyond that initial discovery. As the Department knows, this is a common mining practice, particularly on federal lands where the modest claimstaking requirements make it relatively inexpensive to pursue additional exploration in areas adjacent to an operating mine. The impacts of such expanded activity are apparent at the Bingham Canyon mine in Utah, in Butte, Montana, across the Carlin Trend of Nevada and elsewhere. Indeed, that potential arose at the Grand Canyon itself, when operators of the Orphan Mine in the 1960s pressed for authority to follow an ore discovery on claims then outside of the Grand Canyon National Park into the Park itself. Such scenarios, common to hardrock operations, are not accounted for in the DEIS, but could easily develop given the volatility of metals prices and the common practices of the hardrock mining industry. They would result in longer-lived and larger operations than those considered in the DEIS, greater levels of water usage and possible pumping over longer periods of time, as well as additional opportunities for waste materials to be spread through the environment. The cumulative impacts of these scenarios should have been considered in the DEIS.	This question was considered during the development of the RFD. Breccia pipes are relatively small, isolated geologic deposits. Expansion of mining into the formation beyond the immediate pipe is not foreseeable. The types of deposits cited by commenter as examples of mine expansion in the typical large scale open pit mines associated with disseminated gold and copper deposits. These mines are very different deposit types than the small discrete underground mining operations associated with uranium-bearing breccia pipe deposits in the proposed withdrawal area. However, it is widely known that multiple breccia pipes might occur in the same area, and that these might be developed together. This possibility is considered in Appendix B of the FEIS. To simplify the RFD, each breccia pipe was estimated to be mined independently, even if discovered together. In the known cases where this has occurred (EZ-1/EZ-2/What is a good example), the footprint has been larger than a single pipe, and the production duration has been significantly longer as well. Thus, on a per-breccia-pipe basis, handling each mine individually is acceptable.
Pew Environment Group	225274	14	Another assumption regarding the likely extent of mining activity deserves reconsideration. For purposes of the DEIS, the Department assumes that no milling would take place in the segregation areas themselves. It assumes that the current industry plans to haul ores to the existing uranium mill in Blanding, Utah would remain unchanged, regardless of the level of actual mining activity, the price of uranium or the price of oil. We agree that this is a possibility, but disagree strongly that it represents the only foreseeable scenario. Depending upon the price of uranium and	The permitting, construction, and operation of a uranium mill facility within the proposed withdrawal area is not considered reasonably foreseeable due to sufficient existing milling capacity in the region for the uranium resource present and the large capital outlay such a project would require. It was therefore not included in the RFD. Estimating the location, size, and operating parameters for such a low probability

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			future discoveries in what USGS describes as thousands of possible breccias pipes in the area, a much larger amount of uranium ore could be mined than that arbitrarily predicted in the DEIS. If extensive mining were to occur at the same time that oil prices rose, the cost of ore hauling operations or competition for access to the Blanding mill from additional mines in Utah could drive the economics of a Grand Canyon regional uranium mill. Failure to evaluate such a scenario seriously underestimates the deleterious impacts that could result, impacting the Park and its visitation, the Colorado River and the critically important deep R-aquifer. The risks associated with milling and mill tailings disposal are substantial, particularly in an area subject to relatively high winds and frequent flash flooding. Any tailings disposal facility would have to be carefully managed, not only through its operational life, but for decades to come. Under the Uranium Mill Tailings Radiation Control Act, this area would present a long-term radiation hazard and be permanently off limits to any activities or visitation. Such a use would clearly be incompatible with the natural resource protection goals of the broader area and the recreation use of the Park, the nearby Monuments and the nearby wilderness areas.	development would be too speculative to inform the EIS. Should such a uranium mill proposal be put forward in the future it would have to undergo its own permit process and would not escape environmental review.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	8	The DEIS overstates and misrepresents the potential ore production and corresponding economic benefits of mining. The DEIS presumes favorable future market and investment conditions in its characterization of Reasonable Future Development (RFD) and ignores the potential for downturns in uranium spot prices and capitol investment as could be catalyzed by global events. Global events catalyzed downturns in the 1980s, 1990s and, in the wake of Japan's nuclear crisis, similar downturns are again underway. The effect of these assumptions is to inflate the environmental consequences of Alternative B, assessed in Chapter 4 of the DEIS. In doing so, the DEIS minimizes the potential beneficial environmental impacts that would occur if new uranium claims were not allowed to be developed during the 20-year withdrawal.	While fluctuations in future uranium prices are foreseeable, the decision was made to assume that for the purposes of the RFD and FEIS uranium prices would remain at or above the current level of $40/pound. This approach was considered appropriate because a) this price level is relatively conservative and therefore does not overestimate the economic impacts of mining based on short-term price spikes, and b) at this price it is known that mining uranium in breccia pipe deposits is economically viable. While the exact dollar amount was not expected to remain constant it was decided that the RFD estimate would be based on the assumption that prices would generally remain sufficient to support operations. To do otherwise would require speculation not only on economic conditions but other global events (e.g., Japan earthquake, arms reduction efforts, etc.) that simply cannot be predicted with any degree of accuracy.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center	225279	40	The RFD assumes that 11 mines would be developed under Alternative B. This assumes that the four mines with previously approved plans of operations would be mined. But these plans were approved in the 1980s, as were their assessments of environmental impacts. In the case of the Canyon Mine, the U.S. Forest Service has indicated that a new plan of operations and a new environmental impact statement will need to be completed before that mine can be reopened (personal communication	The comment asserts that the RFD incorrectly described the reasonably foreseeable development under Alternative B, C, and D, and essentially states that the RFD should have concluded that mining is not reasonably foreseeable on any lands that would be withdrawn. BLM disagrees with the commenter because it is not reasonably foreseeable that there

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
for Biological Diversity			with Kaibab Forest Supervisor Mike Williams). Changing environmental, economic, and legal conditions may make it cost prohibitive to invest in the process of permitting and operating a uranium mine near the south entrance of Grand Canyon National Park. Therefore, we question whether it is reasonable to assume "business as usual" and that all mines with preexisting plans of operations will be mined. The RFD further assumes that seven mining claims that have confirmed uranium resources will also be mined under Alternative B. For the purposes of the RFD scenario, it is assumed that these breccia pipes have valid existing rights and would be mined. However, the BLM project manager Chris Horyza stated publicly on April 7 that none of the claims within the proposed withdrawal area have valid existing rights. Again, we question whether it is reasonable to assume that these seven mines would be developed if the Secretary of the Interior's proposed withdrawal is adopted. An objective assumption would be to start with the fact that none of these claims have valid existing rights, rather than to assume that they do (page B-39). The effect of these assumptions is to inflate the environmental consequences of Alternative B, assessed in Chapter 4 of the DEIS. Similar assumptions are made in assessing consequences for Alternatives C and D. In doing so, the DEIS minimizes the potential beneficial environmental impacts that would occur if new uranium claims were not allowed to be developed during the 20-year withdrawal. The Final Environmental Impact Statement should use an objective set of activity assumptions when assessing the environmental consequences that would result under Alternatives B, C and D.	would be no mining on lands withdrawn under any of the action alternatives. As noted in the comment, there are 4 mines with approved mining plans of operations in the proposed withdrawal area, including one mine that is currently producing uranium ore. Because there is currently mining occurring, and because the remaining three mines operating under interim management with approved mine plans have indicated to the surface managing agencies that they plan to mine the ore remaining in their deposits, the RFD appropriately considered mining at these four permitted operations, as well as of the seven known breccia pipes where there had been significant enough drilling and sampling to estimate uranium reserves, to be reasonably foreseeable under all alternatives.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	41	The BLM and associated consultants and contractors should be held accountable for failing to provide an objective and independent source for a key assumption used in the DEIS analysis of economic impacts derived from uranium mining in northern Arizona. As concluded in Attachment 1: The source of the estimated output of 3 million pounds of U3O8 per mine is indicated on page B-26 of Appendix B as the American Clean Energy Resources Trust (ACERT), which has a vested interest in the uranium assets of northern Arizona on behalf of its members. ACERT issued an economic impact report prepared by Tetra Tech entitled "Economic Impact of Uranium Mining on Coconino & Mohave Counties, Arizona in September 2009." By relying on the Tetra Tech report, the agency introduced an unwarranted and blatant bias into a NEPA analysis that is supposed to objectively evaluate the impacts of the proposed action	As described in Appendix B of the FEIS, the ACERT estimate was not taken at face value but was independently verified by looking at the amounts of uranium produced from the historic mines in the area. The result of that estimate was 3.1 million pounds per mine, compared to the ACERT estimate of 3.0 million pounds per mine. The assumption is based on more than just the ACERT report (ACERT 2009), and is considered reasonable and unbiased.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center	225279	59	We question the assumption for the average uranium ore body per mine of 3 million pounds or 1,500 tons of U308. This assumption is more than twice the expected output from existing mines that are currently in production or permitted and planned for production in the near future. It is a fundamental assumption that is used throughout the economic analysis.	See response 225279:41

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
for Biological Diversity				
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	63	The assumption for the average uranium ore body per mine of 3 million pounds of U308 exceeds the expected output from four existing mines that are currently in production or permitted and planned for production in the near future. Those four mines, Arizona 1, Kanab North, Pinenut and Canyon, are expected to average 1.2 million pounds of U308 (Tables B-11 and B-12 on page B-35). We question whether the assumptions used in the development of withdrawal. scenarios seriously overstate the potential mine output for northern Arizona and, as a result, overstate the economic impacts of mining on the region. * See submittal number 225279 for detailed tables	See response 225279:41
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	64	Similarly related to Table B-12 on page .B" -35, the ore tonnage for the (existing four mines is listed as 276,166 or 69,000 tons per mine. The number of haul trips for 26 new mines of 289,120 calculates to 11,120 haul trips per mine or 278,000 tons of ore per mine based on 25 tons per haul trip. We question how the ore tonnage for each new mine (278,000) nearly equals the total ore tonnage for the four existing mines (276,116). These estimates extend the production time estimated for each mine to three years when the new mines might require fewer production years. This assumption drives the economic impact analysis and could lead to overstating the expected impact in northern Arizona. *See submittal 225279 for detailed tables	See Comment 242664:13. The amount of uranium associated with known deposits has been revised in the FEIS.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	65	The source of the estimated output of 3 million pounds of U308 per mine is indicated on page B-26 of Appendix B as the American Clean Energy Resources Trust (ACERT), which has a vested interest in the uranium assets of northern Arizona on behalf of its members. ACERT issued an economic impact report prepared by Tetra Tech entitled "Economic Impact of Uranium Mining on Coconino & Mohave Counties, Arizona" in September 2009. That report outlines historic mining activity in the region in Table 2 on page 9. A copy of the table follows: * See submittal 225279 for detailed table * In actuality, according to the table, the historic output per mine in northern Arizona is 2.7 million pounds of U308, not 3 million pounds. This overstates the average output by more than 10%. In addition, the data is skewed by the output of The Hack Canyon II mine at 7 million pounds of U308. A more logical output estimate may be the median value rather than the average due to the extremely high output of one mine. The median value is 1.4 million pounds. Also, the number of tons of ore mined in the seven mines averages 210,563 with a median value of 133,822 tons. These actual production values are much less than the forecasted 278,000 tons of ore produced per mine contained in the DEIS. Once again, the overstatement of the forecast estimates in the DEIS creates an overstatement of the economic impact of mining on northern Arizona.	See response 225279:41

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	66	The Denison Mines' website contains a table of expected ore tonnage and uranium output for the Arizona 1 mine and the four additional mines that are planned and permitted in the region. The estimates were obtained from technical reports prepared by Scott Wilson, an engineering firm that is now part of URS Corporation. Those forecasts show similar results as previously mentioned - that the mining of ore and output of U308 is much less than 3 million pounds ofU308 per mine. In the case of the five mines noted below, the amount of ore mined averages 92,840 tons, producing nearly 1.1 million pounds of U308. * See submittal 225279 for detailed tables * In summary, the estimated output of 278,000 tons of ore and 3 million pounds of U308 from each mine appears to seriously overstate the expected economic impact of uranium mining on northern Arizona. These assumptions need further investigation and support.	See Comment 242664:13. The amount of uranium associated with known deposits has been revised in the FEIS.
National Mining Association	225281	8	The failure of the DEIS to mention or incorporate the information about hidden breccia pipes seems to be a deliberate attempt to discount the true impacts of the proposed withdrawal.	Hidden pipes are not explicitly described in the USGS methodology for estimating uranium endowment, but they are incorporated into the numerical estimate. The USGS estimate of uranium endowment extrapolates from known conditions within an area known as the Hack-Pinenut control area. Many of the pipes discovered within the control area were exposed pipes. However, the uranium resources within the control area also included the Hack 2 pipe, which was a hidden pipe. Since this was part of the resource extrapolated to the proposed withdrawal area, with respect to the RFD, hidden breccia pipes are part of the uranium endowment. As such, mining of hidden breccia pipes is already incorporated into all aspects of the FEIS analysis.
VANE Minerals	242650	11	Section 4.1.1. The DEIS assumes a large number of documented mineralized pipes have the potential of being mines, when in fact most of the pipes listed do not contain enough reserves nor have the exploration potential to be economic. It does not appear that the authors are experienced in mining economics or checked with industry experts familiar with the details to confirm their assumptions.	The comment is not borne out by the actual RFD approach. With respect to mineralized pipes, in the absence of an actual estimate of uranium reserves, only 15% are considered to have the potential of being mines.
Arizona Rock Products Association	242654	3	Significant reservations about how the Draft Environmental Impact Statement(DEIS) can seemingly ignore credible resource estimates produced by BLM and the USGS (Circular 1051) that conclude that the district has the potential of becoming one of the most important uranium-producing regions in the United States. In other words, how can the DEIS arbitrarily reduce a 300 to 400 million pound uranium endowment (as estimated by the USGS and others) to a relatively unremarkable resource of merely 45 million pounds?	This comment misunderstands the USGS endowment figures. The entire uranium endowment includes ore grades down to 0.01%. This is much lower grade than what is considered economic to mine. By contrast, historic uranium mines of this type averaged over 0.5% grade ore, and the breccia pipes currently expected to be mined average over 0.25% grade ore. Only a portion of the USGS-estimated endowment can be considered economic and hence likely to be mined under the RFD. To determine that amount a correction

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				factor of 15% was used, yielding the 45 million pounds.
Arizona Rock Products Association	242654	4	ARPA has learned that resource companies have utilized remote sensing and geophysical surveys to locate hundreds of previously-unknown anomalies within a small portion of the proposed withdrawal area. We strongly believe that these surveys have validated the existence of hundreds of undiscovered pipes in the withdrawal area and consequently should be considered in the resource estimate.	Hidden pipes are not explicitly described in the USGS methodology for estimating uranium endowment, but they are incorporated into the numerical estimate. The USGS estimate of uranium endowment extrapolates from known conditions within an area known as the Hack-Pinenut control area. Many of the pipes discovered within the control area were exposed pipes. However, the uranium resources within the control area also included the Hack 2 pipe, which was a hidden pipe. Since this was part of the resource extrapolated to the proposed withdrawal area, with respect to the RFD, hidden breccia pipes are part of the uranium endowment. As such, mining of hidden breccia pipes is already incorporated into all aspects of the FEIS analysis. The techniques indicated in the comment are discussed in Appendix B of the DEIS.
Arizona Rock Products Association	242654	9	Although many statements from environmental groups supporting the withdrawal cite the total number mining claims in the area as the actual number of potential mines, this is far from the reality. However, the DEIS does nothing to dissuade a reader from this assumption and, as previously discussed, does little to accurately estimate how long (and how difficult) it would take to establish a VER and properly permit all of these 5,300 mining claims. Additionally, typically less than one percent of these mines would actually be developed.	The comment indicates the extremely low percentage of mining claims that ever become mines is not properly disclosed. The total number of mines estimated to occur under any scenario over the next 20 years is 30. This represents less than 1% of the 5,300 mining claims, similar to the percentage indicated in the comment.
Arizona Rock Products Association	242654	15	In Appendix B the DEIS assumes that the price of uranium will remain stable at around $40 per pound for the full 20 year withdrawal. However, since the DEIS was written, the price of uranium has already increased dramatically from the $40/lb. level. The spot price for uranium reached $72/pound in January 2011 and subsequently settled to $611lb. in early April. Further, as shown on Figure B-3, yearly reactor requirements for uranium have exceeded the annual production of uranium since approximately 1990. As global stockpiles of uranium have been gradually depleted, the price of uranium will inevitably rise and the pace of worldwide uranium consumption suggest future prices will remain well above the $40/lb. level assumed in the DEIS. This further discredits the RFD as commodity pricing will influence mining activity and projected revenues, dramatically undervaluing the endowment and incorrectly minimizing the financial impact of the withdrawal.	While fluctuations in future uranium prices are foreseeable, the decision was made to assume that for the purposes of the RFD and FEIS uranium prices would remain stable at a level of $40/pound. This approach was considered appropriate because a) this price level is relatively conservative and therefore does not overestimate the economic impacts of mining based on short-term price spikes, and b) at this price it is known that mining uranium in breccia pipe deposits is economically viable.
Arizona Rock Products Association	242654	18	ARPA is also concerned that the DEIS artificially and arbitrarily reduces the size of this massive endowment, overestimates the amount of resources that could reasonably be extracted after proving Valid Existing	Other comments have suggested alternatives to the use of 15% of the endowment figure (see Comment 225256:127); however, these techniques were not

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Rights, and underestimates the loss of royalties, jobs, taxes and investments resulting from the withdrawal.	found to have any better justification than that used in the RFD.
Arizona Rock Products Association	242654	20	Despite the fact that the RFD irrationally discounts the USGS estimate of uranium endowment, any estimate of the endowment is based solely on exposed breccia pipes or pipes with visible collapse features and does not consider the recent advances in detecting mineralized breccia pipes without surface collapse expressions.	Hidden pipes are not explicitly described in the USGS methodology for estimating uranium endowment, but they are incorporated into the numerical estimate. The USGS estimate of uranium endowment extrapolates from known conditions within an area known as the Hack-Pinenut control area. Many of the pipes discovered within the control area were exposed pipes. However, the uranium resources within the control area also included the Hack 2 pipe, which was a hidden pipe. Since this was part of the resource extrapolated to the proposed withdrawal area, with respect to the RFD, hidden breccia pipes are part of the uranium endowment. As such, mining of hidden breccia pipes is already incorporated into all aspects of the FEIS analysis. The detection techniques indicated in the comment are discussed in Appendix B of the DEIS.
Arizona Rock Products Association	242654	21	DIR suspects that the DEIS has massively underestimated the number of mineralized breccia pipes available for development and consequently have not adequately constructed an analysis in the RFD that correctly identifies and addresses the massive financial implications of closing the withdrawal area to development. Clearly, a withdrawal would essentially destroy the entire productive potential of the highest grade and most favorable endowment of uranium mineralization in the United States.	Other comments have suggested alternatives to the use of 15% of the endowment figure (see Comment 225256:127); however, these techniques were not found to have any better justification than that used in the RFD.
Quaterra Resources, Inc.	242664	5	Perhaps the most erroneous assumption in the DEIS is that resources of the district are not capable of sustaining mining for 20 years. At an average production of 1.5 million lbs of uranium per year per mine, an average of 3 million lbs produced per mine, and even using a gradual ramp-up of production, six continuously operating mines could produce 160.5 million lbs in 20 years; only one half the total estimated endowment of the subject lands.	This comment misunderstands the USGS endowment figures. The entire uranium endowment includes ore grades down to 0.01%. This is much lower than is considered economic to mine. By contrast, historic uranium mines averaged over 0.5% grade ore, and pipes currently expected to be mined average over 0.25% grade ore.
Quaterra Resources, Inc.	242664	10	Another related issue is the presence of "split estates" or land parcels within the withdrawal area that have separate surface and mineral ownership. Unfortunately, all maps in the DEIS that show ownership or control of the lands within the proposed withdrawal area are based on surface ownership rather than mineral ownership. Having at least one map in the DEIS that shows mineral ownership would make it easier to identify the split-estate sections where mineral control may not be subject to the withdrawal. Obviously, the presence of extensive split estate parcels would substantially change the key assumptions listed in the DEIS, specifically those relating to the Reasonably Foreseeable Development (RFD)	A map showing mineral ownership has been included in the FEIS.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			scenarios discussed in Appendix B.	
Quaterra Resources, Inc.	242664	12	A significant basis for nearly every assumption and comparative analysis in the DEIS is the size of the endowment area, the number of mineralized breccia pipes and the average uranium resource of a mineralized breccia pipe. Lacking a basic understanding of the principles of breccia pipe formation, subsequent mineralization and the mechanics of breccia pipe exploration and eventual development, the DEIS constructs a seriously flawed RFD that significantly understates the massive mineral potential of the area. There are literally thousands of breccia pipes in northern Arizona. The USGS Open File Report (OFR-89-550) shows the mapped locations of 1,296 pipes in northern Arizona. The assumption made on page B23, Appendix B, that only*15% of the mineralized pipes could be economical to mine* is seriously flawed and the justification that further discussions with industry experts did not lead to a refinement of this assumption reflects a clear bias towards minimizing the impacts of the withdrawal or a serious lack of understanding of the economic mineral potential of the subject area.	Other comments have suggested alternatives to the use of 15% of the endowment figure (see Comment 225256:127); however, these techniques were not found to have any better justification than that used in the RFD.
Quaterra Resources, Inc.	242664	13	The only way to accurately estimate the potential uranium resource of the Northern Arizona Proposed Withdrawal Area (NAPWA) is to look at the results of exploration drilling in the subject area. By the end of 2009, a total of 45 breccia pipes have been confirmed in the NAPWA by deep holes drilled from the surface to explore the favorable Hermit shale horizon for uranium mineralization. The approximate location of each of these pipes is shown in Figure 1. **(pg 7 letter # 242664)** These 45 confirmed breccia pipes include 16 uranium deposits defined as occurrences with estimated resources thought to exceed 100,000 lbs. of U3O8, 19 mineralized pipes where uranium mineralization has been identified by drilling, but no estimate has been made or drill hole data are insufficient to define a resource total in excess of 100,000 lbs., and 10 pipes with an undetermined status where drilling has encountered breccia below the lower Toroweap horizon but the amount of drilling to date has not been sufficient to delineate uranium mineralization **(Table 1). (pg 8**) Thus, the number of potentially economic uranium deposits that have already been defined in the NAPWA represents 35% of the total number of breccia pipes discovered to date; not less than 1 % (10% of less than 8%) as suggested by Weinrich and Sutphin (1988) and much more than 15% as used by the DEIS study on page B-23 under 'Known Mineralized Breccia Pipes with No Estimate of Uranium Resources. To underscore the 35% figure, one must bear in mind that the total production from developed deposits in the NAPWA has historically been more than 2.5 times the amount estimated from surface drilling alone **(Table 2). (pg 9) *see submittal #242664 for detailed Table Information** Because much of the mineralization in breccia pipes is hosted in near vertical ring fractures and ore shoots, ore reserves cannot be fully defined with holes drilled from the surface. Consequently,	Other comments have suggested alternatives to the use of 15% of the endowment figure (see Comment 225256:127); however, these techniques were not found to have any better justification than that used in the RFD. See Comment 242664:20 concerning inclusion of blind pipes in the RFD. The commenter provides information supporting the fact that total production of uranium has historically been 2.57 times great than the amount estimated from surface drilling alone. This information is new and warrants revisions to the RFD. The overall uranium resource considered in the RFD consists of 4,147 tons of U3O8 from drilling estimates of known deposits, 4,500 tons of U3O8 estimated in other known breccia pipes that haven't been adequately characterized, and 33,155 tons of U3O8 in as-of-yet undiscovered breccia pipes (Table 3.3-1). The new information presented by the commenter leads to the conclusion that the amount of uranium in known deposits (4,147 tons) is likely underestimated. A more reasonable estimate would be 10,658 tons (i.e., 4,147 x 2.57). This information has been incorporated into Section B.8.1 of the FEIS. It has not resulted in a

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the final determination of a deposit's resource and mineable reserves must include an extensive program of underground drilling. Additional underground drilling on the 19 partially tested pipes could easily raise the 35% figure to well above 50% or 22 potentially economic uranium deposits in the NAPWA. Yet these estimates represent only a fraction of the total mineral potential of the proposed withdrawal area. All but two (Hack 2 and A01) of the 45 known breccia pipes have reached the surface. Hack 2 and A01 are considered "blind" pipes, because the pipe structures have stopped formation before reaching the surface. Containing 7 million lbs in a single breccia pipe, the blind Hack 2 breccia pipe is also the largest uranium deposit yet found in the district in part because it has not undergone secondary collapse. A realistic estimate of the total mineral potential of the NAPWA must include undiscovered blind pipes as well as those that are manifested at the surface.	change in the number of mines, but has resulted in changes to the amount of uranium mined and the expected number of haul trips and the amount of uranium used for analysis in Chapters 3 and 4.
Quaterra Resources, Inc.	242664	14 & 15	An estimate of the total mineral potential must also take into account where the pipes occur and to what stratigraphic level they penetrate. Nearly all the known mineralized pipes and all of the economically viable uranium deposits in the region have been found in a N-S trending mineralized "corridor" that is approximately 45 miles wide by 110 miles long. All of the proposed withdrawal area is in this corridor because the area was selected by drawing a line around the focus of the claim staking activity. Most of the remaining corridor has already been withdrawn from mineral entry. More than 3 dozen pipes drilled outside of the corridor by Energy Fuels Nuclear had large and well developed pipe structures, but lacked significant mineralization. A withdrawal of the NAPWA would not just impair 12% of the most favourable endowment (Otton and VanGosen, 2010) but would essentially destroy the productive potential of the Northern Arizona uranium district. For a breccia pipe to be mineralized, it must have penetrated the Coconino Sandstone and preferably the lower Toroweap Formation. Sandstone breccia from the Coconino acts as the principal host for uranium mineralization in the pipes and is believed to be the conduit for uranium mineralization. The Brady Canyon member of the Toroweap is considered an important source for reductants necessary for precipitation of uranium in the pipes (Krewedl and Carisey, 1986). The Northern Arizona uranium district is unique in the fact that a cross section through the center of the district is visible in the walls of the Grand Canyon. Both the position of the mineralized corridor and the total number of mineralized pipes within it can be estimated by examining these outcrops. The USGS Open File Report (OFR-89-550) shows the mapped locations of 1,296 pipes in northern Arizona. A total of 379 of these mapped pipes are within the Grand Canyon National Park; many containing high grade uranium mineralization eroding naturally into the Colorado River. A surface scintilometer examination in 1979 of just a few of the naturally occurring pipes in the Park identified four pipes that peaked the instrument with more than 130 times normal background radiation.	See Comment 225256:126 and 225256:128

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			(One of these pipes, never touched by mining activities, is located in the park above and just NE of the Park Services' Phantom Ranch headquarters.) A study of the relative pipe densities at different stratigraphic levels provides an estimate of the total number of mineralized pipes to be expected in the NAPWA. More than 90% of all the pipes mapped by the USGS are within the deeper canyons where they are exposed by erosion of the younger strata. Approximately 32 pipes per 100 square miles outcrop in Carboniferous or older strata.	
Quaterra Resources, Inc.	242664	14 & 15	Continued... This same pipe density or frequency is probable at depth throughout the NAPWA, but the number of known pipes decreases dramatically below the cover of successive layers of younger sediments until fewer than 2 pipes are evident over a surface area of 500 square miles in the upper Triassic sequence (Figure 2). Clearly, the upper level of stoping by collapse varies and many blind pipes occur at depth with no surface evidence of a pipe throat. If these structures penetrate the Coconino Sandstone, an ore body may exist with no pipe feature at the surface. Figure 2: Diagrammatic Cross Section of the Northern Arizona Strip Uranium District showing the approximate frequency and relative distribution of solution collapse breccia pipes within various stratigraphic units. (Source: Spiering, 2010, Exploration and discovery of blind breccia pipes: the potential significance to the uranium endowment of the Arizona Strip District, Northern Arizona - Presentation to SME Annual Meeting-Phoenix, AZ.) A log-log plot of the relative pipe densities versus the cumulative sedimentary cover is shown in (Figure 3). At the critical lower Toroweap level (thought necessary for a pipe to contain mineralization), the estimated pipe density is approximately 12 pipes per 100 square miles. When this density is multiplied times the 1,689 square mile NAPWA area, a total of approximately 220 pipes might be expected to contain mineralization. If we use the 50% estimate for the number of mineralized pipes within the mineralized corridor that are economically viable from the results of past drilling, then a total of 110 economically viable uranium deposits can be expected within the NAPWA. If a greater percentage of blind pipes contain economically viable deposits because they have not undergone postmineral collapse, this total number could be significantly higher Figure 3: Log- Log plot of breccia pipe density vs. cumulative thickness of sedimentary cover.	See Comment 225256:126 and 225256:128
Quaterra Resources, Inc.	242664	14 & 15	Continued... (Source: Spiering, 2010, Exploration and discovery of blind breccia pipes: the potential significance to the uranium endowment of the Arizona Strip District, Northern Arizona - Presentation to SME Annual Meeting-Phoenix, AZ.) An average of 3 million pounds of uranium (produced and remaining) has been defined per developed (those that have been drilled from the surface and underground) deposit in the NAPWA (Table 3). If we use this average number times the estimated 110 potentially economically viable uranium deposits in the subject area, the	See Comment 225256:126 and 225256:128

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			total uranium potential of the NAPWA is approximately 330 million lbs; an estimate that is almost identical to the 326 million pounds) U3O8 estimated for the withdrawal area by the US Geological Survey (Otton and VanGosen, 2010) after a refinement of the potential resource endowment estimated by the USGS in Circular 1051 (Finch and others, 1990). Table 3: Produced and remaining uranium resources of all developed breccia pipes in the NAPWA (Source: Energy Fuels Nuclear Inc. Internal Memorandum, 1990). The U.S. Geological Survey's estimate is less empirical and more statistical, but recent exploration in the subject area provides additional indirect evidence of the area's resource endowment. An airborne geophysical survey conducted by Quaterra Resources Inc. in 2007 that covered 422 square miles of the proposed withdrawal area identified all known pipes in the surveyed area and more than 200 anomalies with similar geophysical signatures. The initial drilling results of 7 of the anomalies achieved a 70% success record. If only 20% of the geophysical anomalies are proved to be economically viable deposits and the remaining un-surveyed portion of the NAPWA has a similar potential, approximately 160 deposits potentially representing 480 million lbs. of U3O8 may lie within the subject area. Regardless of what the actual uranium endowment of the area is, any reasonable estimate will substantiate the assessment of the (August 2010) BLM Mineral Report on the mineral potential of the proposed withdrawal area that concludes: "Failure to develop uranium resources on the subject lands that have the potential of becoming part of the second most important uranium-producing region in the United States has far reaching economic implications, which are beyond the scope of this report." The BLM Mineral Report classifies the uranium potential of the area as "(H/D)"; the highest classification possible for both potential and level of certainty. *see comment # 242664	
Quaterra Resources, Inc.	242664	16	There are several errors in the assumptions made in the production time frame (p. B-29) Appendix B of the RFD section of the DEIS that appear intentional to reduce the economic importance of the resources in question. The most important of these are the number of mines (30) that could be sustained by all known and undiscovered resources. The resource potential of the proposed Northern Arizona Withdrawal Area (NAPWA) has been estimated by several studies (discussed above) to exceed 300 million lbs. The assumption that this resource is not capable of sustaining mining for 20 years is erroneous. The uranium mineralization of the proposed withdrawal area represents the highest grade and most profitable per pound production in the U.S. while having one of the smallest surface disturbances and environmental impacts on any uranium district in the world. At an average production of 1.5 million lbs of uranium per year per mine, an average of 3 million lbs produced per mine, and even using a gradual ramp-up of production, six continuously operating mines could produce 160.5 million lbs in 20 years (Table 4). Yet this	This comment misunderstands the USGS endowment figures. The entire uranium endowment includes ore grades down to 0.01%. This is much lower than is considered economic to mine. By contrast, historic uranium mines averaged over 0.5% grade ore, and pipes currently expected to be mined average over 0.25% grade ore.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			represents only half of the total endowment of the NAPWA. Because of the errors in the time frame, the economic impact of the proposed withdrawal has been seriously underestimated. An independent report prepared by Tetra Tech in September 2009 "ECONOMIC IMPACT OF URANIUM MINING ON COCONINO AND MOHAVE COUNTIES , ARIZONA" (Attached) uses a six mine - 42 year scenario to model to the economic impact of producing the entire uranium endowment of the NAPWA. The report concluded that the uranium mining operations would provide a significant long-term benefit to the area, state, and region: a direct total sales impact of $18.9 billion over the 42-year duration of the project, with indirect impacts of $10.5 billion, for a total impact of $29.4 billion, resulting in an average annual impact of $700 million.	
Quaterra Resources, Inc.	242664	20	In Appendix B, the DEIS discusses uncertainty factors associated with the development of the RFD. One of the most significant factors affecting the development of mineral resources is the determination of Valid Existing Rights (VER). Unfortunately, the document fails to recognize the extreme difficulty in proving a VER and also fails to note that in order to demonstrate a VER, a potential mineral resource would need to be located and essentially proven before the initial land segregation beginning July 21, 2009. This would effectively preclude any additional development projects except for those few mines where development activities have already been approved by the BLM or FS.	Under the various withdrawal scenarios (B, C, and D), it is reasonably foreseeable that some of these pipes will be situated on mining claims and that those mining claims will be determined to have valid existing rights. Specifically, a determination that valid existing rights existed was considered reasonably foreseeable if a breccia pipe already has significant enough drilling and sampling data for an estimate of uranium reserves to be conducted.
Quaterra Resources, Inc.	242664	21	Although no work could be done on any claims during the 2-year segregation or after the withdrawal unless validity had already been established or could be established in the future, the RFD goes to great length to discuss and analyze potential development projects stemming from undiscovered mineral deposits in the area. Unfortunately, these projects could NEVER be realized simply because this type of development is specifically prevented by the segregation and withdrawal process. This essentially eliminates 70% of the Reasonably Foreseeable Future Activity discussed in the RFD. Additionally, the prescriptive and time-consuming hurdle of proving a VER could preclude additional mining from those projects without proven mineral reserves. Although it is impossible to predict the outcome of individual VER determinations, it is realistic to assume (contrary to the DEIS RFD assumptions) that not every potential mine site with proven reserves will pass the stringent determination process. In practice, it becomes much harder to develop claims within an area that has been proposed for withdrawal, for two reasons. First, as a precondition of approving a plan of operations within the area, the BLM or FS must determine the validity of the claims, by requiring the preparation of a mineral examination report to: (i) verify the deposits are locatable minerals rather than common variety (salable) minerals; and (ii) verify the claims are based on a bona fide discovery of potentially marketable minerals, under the "prudent man" and	Under the various withdrawal scenarios (B, C, and D), it is reasonably foreseeable that some of these pipes will be situated on mining claims and that those mining claims will be determined to have valid existing rights. Specifically, a determination that valid existing rights existed was considered reasonably foreseeable if a breccia pipe already has significant enough drilling and sampling data for an estimate of uranium reserves to be conducted.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			"marketability" tests, which essentially require tangible evidence in the record of prospecting or geological indications or sample results that justify the staked sidelines and end-lines of the claim and indicate future mineral development within the claim may be warranted. Refer to 43 C.F.R. § 3809.100 and 43 C.F.R. §§ 3830.11, 3830.12 (stating factors for determining minerals are locatable); 65 Fed. Reg. 69998, 70026-27 (explaining the "prudent" man and "marketability" tests and their part in a mineral examination report). Second, if the area proposed for withdrawal includes an ACEC, then the BLM will not approve the plan of operations if it is not satisfied that the plan includes mitigation measures necessary not only to prevent unnecessary and undue degradation of the environment but also to preserve sufficiently the resource that the ACEC was established to protect. See 43 C.F.R. §§ 3809.11(c)(3), 3809.21. Thus, even if the claims within an area of proposed withdrawal are determined to be valid, the BLM or FS can potentially hold the claimant in an interminable do-loop of notices of deficiency, one after the other, concerning the sufficiency of the mitigation measures proposed in the plan of operations relative to the mitigation measures specified in the RMP or FEIS for the ACEC, until the claimant gives up hope of the possibility of submitting a Plan of Operations that will satisfy the BLM. Consequently, Quaterra contends that by not estimating the difficulty of establishing a VER and authoring an approvable Plan of Operations, the RFD significantly overestimates the amount of potential future development in the withdrawal area. This substantially mischaracterizes the magnitude of the uranium resources lost to the withdrawal. However, an uninformed reader could assume from reviewing the RFD that uranium resources available for mining after the withdrawal would essentially match or exceed the industry's limited ability to safely extract these resources.	
Quaterra Resources, Inc.	242664	27	In Section B.5 the DEIS reports that approximately 5,300 claims are located within the three withdrawal parcels. Unfortunately, the DEIS does not discuss the statistical probability of developing a mine from any of these claims. Empirically, only 1% to 2% of exploration projects proceed to development and then only 1% to 2% of development projects actually advance to mining. Consequently, the number of claims filed is usually 50 to 100 times larger than the number mines that would ever be developed. Although many statements from environmental groups supporting the withdrawal cite the total number mining claims in the area as the actual number of potential mines, this is far from the reality. However, the DEIS does nothing to dissuade a reader from this assumption and, as previously discussed, does little to accurately estimate how long (and how difficult) it would take to establish a VER for all of these 5,300 mining claims.	See Comment 242664:9
Quaterra Resources, Inc.	242664	28	In Subsection B.7.1 the DEIS notes that the value of other commodities or metals that could be recovered from the mining of the breccia pipes would not be sufficient to drive mine development. But on pages 3-31 and 3-32	The EIS was revised to acknowledge rare earth elements, but there isn't any indication that they will drive development or change the way mining occurs.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the DEIS states that a variety of precious metals including copper, gold, silver and vanadium have been found within exposed breccia pipes. The DEIS further concludes that the *presence of uranium minerals within breccia pipes has been of the most interest…to the mining industry*.Regrettably, the DEIS interprets this industry focus to mean that there are no other economically-viable minerals which may be an incorrect assumption. Of particular interest is rare earth elements which were not specifically listed as one of the other metals considered. However, an investigation conducted by the AGS on breccia pipe exploration projects reported high concentrations of rare earth elements. Considering the world-wide interest in and demand for the rare earth elements, and the current historic commodity prices for copper gold, silver and vanadium, mineralized breccia pipes could represent a potentially valuable source for other minerals that have been completely omitted from the DEIS.	However, this does not change the outcome of the RFD. The underlying assumption is that uranium prices would remain at levels sufficient to support economic development of mines. The impetus to develop mines is already incorporated into the RFD and a higher price incentive due to the presence of rare earth metals won't change this.
Quaterra Resources, Inc.	242664	29	In Subsection B.7.2 the DEIS assumes that the price of uranium will remain stable at around $40 per pound for the full 20 year withdrawal. The limited range of price history shown on Figure B-4, might convince anyone not familiar with commodity price fluctuations or uranium market conditions that this is a realistic assumption. If the price history were traced back to approximately the same time-frame as that used for production history shown on Figure B-3, the earlier price fluctuations of uranium would be evident, especially the sharp rise in the 1970's, the dramatic fall in 1979-1980 after the Three Mile Island incident and the less dramatic fall after the Fukushima disaster. A review of the price history shown on Figure B-4 would not reveal that the price of uranium was kept artificially low from the mid 1990's to the early 2000's by the reprocessing of uranium recovered from decommissioned nuclear weapons in the arsenals of the U.S. and former Soviet Union. However, as shown on Figure B-3, yearly reactor requirements for uranium have significantly exceeded the annual production of uranium since approximately 1990. And as global stockpiles of uranium are gradually depleted, the price of uranium will inevitably rise. Since the DEIS was written, the price of uranium has already increased dramatically from the $40/lb. level. The spot price for uranium rose to $72/lb. in January 2011 and subsequently settled to $61/lb. in early April. Regardless, the pace of worldwide uranium consumption suggest futures prices will remain well above the $40/lb. level assumed in the DEIS. This further discredits the RFD as commodity pricing will influence both mining activity and increase revenues associated with the alternatives analysis. It also dramatically undervalues the endowment, which incorrectly minimizes the financial impact of the withdrawal.	See Comment 242664:14
Quaterra Resources, Inc.	242664	31	Perhaps the most erroneous assumption in the DEIS is that resources of the district are not capable of sustaining mining for 20 years. At an average production of 1.5 million lbs of uranium per year per mine, an average of 3 million lbs produced per mine, and even using a gradual	This comment misunderstands the USGS endowment figures. The entire uranium endowment includes ore grades down to 0.01%. This is much lower than is considered economic to mine. By contrast, historic

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			ramp-up of production, six continuously operating mines could produce 160.5 million lbs in 20 years; only one half the total estimated endowment of the subject lands.	uranium mines averaged over 0.5% grade ore, and pipes currently expected to be mined average over 0.25% grade ore.
The NAU Project, LLC	242913	1 & 2	The methodology for determining the estimated uranium reserves in the withdrawal areas is flawed. The uranium reserves obtained from Denison Mines or from published technical reports (Scott Wilson RPA) represent, for the most part, the minimum uranium resource that can be calculated from the data available to make a resource calculation. From "Technical Report On The Arizona Strip Uranium Project, Arizona, U.S.A." prepared by Scott Wilson RPA on February 26, 2007 on page 6.7: HISTORICAL RESOURCE ESTIMATE COMPARISON WITH ACTUAL PRODUCTION In its Preliminary Feasibility Report for the Canyon project (dated December 11, 1984), Energy Fuels provided historical reserves/resources estimates for various pipes based on surface drilling only. Scott Wilson RPA has compared those reserve/resource estimates with actual production results in Table 6-2. As can be seen from Table 6-2, the surface drilled estimate does not often correspond to the actual production of the mine. The average estimated uranium resource found in an "unexplored" breccia pipe has been set to 1500 tons U3O8 based on the average production from the above mines. If the surface drilled indication of resource was used, the average estimated resource for a representative ore grade pipe would have been 565 tons vs the 1500 tons that is currently being used. It is a fact that the actual production from a breccia pipe uranium mine is, on average, much greater than the surface drilled resource estimate. The average of the seven "surface drilled to production resource" ratios can be used to provide a better resource estimate for surface drilled ore grade breccia pipes. The average for the above ratios in Table 6-2 is three and this should then become the Production Ratio Factor or PRF! A Vane Minerals press release illustrates my point : http://www.vaneminerals.com/press/pressview/334 The Arizona 1, Kanab North, and Pinenut mines have all been surface drilled and drilled from underground station to such an extent that the estimated resource will be assumed to be the actual production resource.	See Comment 242664:13
The NAU Project, LLC	242913	1 & 2	The EZ-1, EZ-2, and Canyon mines have only been surfaced drilled and so should have the PRF applied to them to determine estimated uranium production resource. The DB, Findlay Tank NW, Findlay Tank SE, Rim, and What breccia pipes should have the PRF applied as well. However, if these breccia pipes have only a relatively few surface drill holes and the resource estimate was based on so few surface drilled holes, then I believe that the generic 1500 ton estimate of uranium resource should be applied to these breccia pipes. Often, exploration companies will provide interim resource figures for "bragging rights" or to let their stockholders know they are making progress. I leave it to the authors of this DEIS to determine which category the above pipes belong in. Not using the	See Comment 242664:13 concerning the use of surface drilling data and uranium reserve estimates The exploration discussion in Section B.4.3 has been updated to include these techniques, and the text in Section B.5 has been modified to indicate that historically it has been the case that only drilling can confirm the presence of a breccia pipe.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Production Ratio Factor underestimates the total uranium resource by 19% and alternately 30% if the DB, Findlay Tank NW, Findlay Tank SE, Rim, and What breccia pipes are adjusted to 1500 tons per pipe. Both the 19% and 30% increases in the estimated uranium resource for the withdrawal area is very significant and the authors of the DEIS need to make adjustment to this section and all other segments of the DEIS that use these figures. The following table summarizes the above. The uranium resources for the DB, Findlay Tank NW, Findlay Tank SE, Rim, and What breccia pipes were evenly divided by these targets after the DEIS resources for the EZ-1 and EZ-2 were subtracted from the original 2362 ton resource for the seven pipes. At the public meeting in Phoenix, I spoke with the gentleman that wrote this section and he confirmed that he knew about the underestimation of the uranium resource due to the surface drilling estimate v. production results issue, but that a decision was made to go with the "published" resource. This is in error and injects a BIAS into the EIS. Remember, this is a resource estimate and so it is entirely appropriate to estimate the uranium resource for surface drilled breccia pipes when there is good evidence to do so. After all, that is exactly what you are doing when you estimate the unexplored ore bodies yet to be discovered at 1500 tons. Is it correct to believe that any of these pipes, if surface drilled, would actually have a defined resource of 1500 tons? The method to estimate uranium reserves should be re-evaluated and corrected. Re-consult with industry experts to get a better estimate of uranium resources for the withdrawal areas. * see submitall #242913 for detialed table info	
The NAU Project, LLC	242913	3	B.5, Page B-15 In most cases, the presence of a breccia pipe can only be confirmed by actual drilling and usually only by drilling deep enough to identify the presence of breccia below the lower horizon of the Toroweap Formation. This statement is not true. The combination of Soil Gas Hydrocarbon (SGH) Analysis and CSAMT geophysics survey can determine with certainty whether a uranium mineralized breccia pipe exist at a given location. The CSAMT survey will model the sub-surface structure of the pipe and the SGH survey and analysis will determine if uranium mineralization is present. Since only breccia pipes have uranium in them in the withdrawal areas, the combination of the two techniques confirms the breccia pipe and its uranium mineralization. New technology makes identifying breccia pipes easier.	This comment is non-substantive. It does not question the accuracy of information used, the adequacy of specific assumptions or methodology, provide new information, or offer reasonable alternatives or changes to alternatives.
The NAU Project, LLC	242913	5	*B.7.2 Page B-18 While production costs can be controlled or anticipated through management and technology, the significant unknown factor will continue to be the price of uranium.* The bold portion of this sentence is false. The price of uranium is past the point where its future price will bar the profitable development of breccia pipe mines. The uranium exploration companies recognize this situation and have therefore invested their resources in the proposed withdrawal area. That the authors of this DEIS	See Comment 225279:8

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			do not explicity recognize this fact is troubling. The other point to recognize is that the Spot Market price for Uranium is the thinnest traded part of the uranium market. The largest majority of uranium is sold through negotiated long term contracts that are usually higher than the “spot” price at any given time. While there is certainly speculative factors in the uranium market place, it is a very,very, small and somewhat exclusive market place that is driven primarily by supply and demand. The uranium marketplace is at the beginning part of a long term supply to demand deficit. There are numerous and detailed analysis available online from multiple sources that confirm this concept and explain it in great gory detail. To suggest that the price of uranium will, for reasons unknown, fall to the point of unprofitability is unreasoned in the face of all the evidence to the contrary. While there are scenarios that could be developed that would cause the price of uranium to fall dramatically, the probability of them happening is remote. Therefore the scenarios of increasing price over time should be applied in the evaluation of impacts in this EIS. There is a basic primer on these concepts at: http://en.wikipedia.org/wiki/Peak_uranium#Uranium_demand	
The NAU Project, LLC	242913	6	B.7.2, Page B-19 Figure B-3 does not have enough context to provide a meaningful interpretation of the graph. Some background information on why uranium prices have fluctuated should be included in this EIS. An excerpt from Uraniumletter International October 2006 gives the following historical explanation of Figure B-3. *** see submittal #242913 for detailed excerpt**	Section B.7.2 of the FEIS has been modified to give better context to the historical uranium prices.
The NAU Project, LLC	242913	7	Page B-19 The statement: *The peak in 2007 was driven largely by global speculation, and prices have since settled to approximately $40/lb. It should be noted that the spot market may not be an accurate indicator of long-term contract prices for uranium, which are what determine the economics of mining specific breccia pipe ore bodies. For the purposes of the RFD scenarios, it is assumed that uranium prices will remain stable at this level. Historically, price changes have been the primary reason for mining companies to operate under interim management; therefore, based on the assumption that prices will remain stable, the mines considered in the RFD are not likely to operate under interim management.* It would be better to explicitly admit that the price of uranium will not fall below the profitability level required to operate a breccia pipe mine. That is exactly what the last sentence in this statement tacitly does. That being done (whew!!!), it does not matter what the particular price of uranium is at any given time period over the next 20 years, but the primary concept is that there will be upward pressure on pricing. For computational purposes, a bar graph for the value of the estimated uranium resources in the withdrawal area could be constructed to demonstrate the range in values (say 50 to 120 dollars) that the uranium would have at various prices with an explanation that the "true value" is unknown but would most probably fall somewhere within this range. To insist on a $40 constant value over 20	The commenter correctly interpreted the intent of keeping the price at or above current levels for the purposes of the RFD. See Comment 225279:8

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			years really serves no purpose at all, but detracts significantly from any sense of institutional competence in the writing of this EIS.	
The NAU Project, LLC	242913	8	The RFD assumes that prices will remain constant at current levels for the next 20 years. (see above and ditto to the Nth power) Prices play a critical role in the extent to which uranium deposits are developed in the United States and in other parts of the world. Relatively higher prices would be anticipated to stimulate additional mining, from both new and existing mines. Additional production would be expected to act as a moderating force on additional price increases. Deviations from this assumption could affect several parts of the RFD, such as the total number of mines and the total uranium mined, which would then carry through to the evaluation of impacts. One of the drivers of uranium prices is world supply. The top five uranium producers (Kazakhstan, Canada, Australia, Namibia and Russia) accounted for 75% of world supply in 2008 and 85% in 2009 (World Nuclear Association 2010a). The United States produces about 3% of world supply. An increase in production by the top producers would be expected to put downward pressure on prices. These changes would affect the other impacts described in the EIS. For example, reduced mining activity may lead to reduced impacts under the No Action Alternative, such as fewer particulate matter emissions, less disturbance of habitat and cultural, historical, or Indian resources, and less displacement of recreation activity. This in turn reduces the differences between the No Action Alternative and any of the action alternatives (B, C, or D). The above Bold and Italicized statements are some what true in a general economic sense, but in the case for uranium, will probably only apply over short time intervals while uranium buyers delude themselves into believing that the increase in production supply is going to ease the structural large gap that exists in real and projected uranium consumption. The second issue is that of depletion of uranium supply. When the lower cost supplies of uranium are mined, these low cost materials are depleted and lost to future production. Accelerating the depletion of these low cost sources to moderate increasing prices (as will happen) will deplete these sources sooner rather than later. The next mining projects available will be those that can be brought online at a higher price, and thus will move prices up to the next pricing tier. However, the late realization that this event will unfold will cause multiple spikes in prices over time because the new projects won't be brought online in time to provide additional supply before the supply falls back into increasing deficit. Rinse and repeat, this cycle of price moderation, depletion, and price increase would be expected to exist for the 20 year time period under consideration. See article from Mineweb at: http://www.mineweb.com/mineweb/view/mineweb/en/page72103?oid=122532&sn=Detail&pid=92730. Recommendation: Ditch the idea that uranium prices are so volatile and mysterious and that the price cannot be figured out. Embrace the concept that we are at a point in history where the price will be increasing over time and that breccia pipe mining will be	See Comment 225279:8

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			profitable for the foreseeable future. The particular price of uranium is not relevant, provided that the price makes breccia pipe mining profitable. The scenario with the highest degree of confidence is uranium prices increasing over time and certainly over the next 20 years. Provide a range of values for the worth of the estimated uranium resource in the withdrawal areas.	
The NAU Project, LLC	242913	9	B.8, Page B-28 Commodity Prices In general, the section headed with "Commodity Prices" makes reference to Table B-2 and to Figure B-4 without supplying any historical context to explain what external events were driving the pricing of uranium. The continually and repeated stated "commodities market volatility" with respect to uranium implies that the reasons for the changes in uranium prices are at the "whim" of some nebulous "Commodities Market" and are therefore beyond credible analysis. This is simply not true. Solution: Provide a "historical" section on how and why the uranium market is the way it is today by looking at the past. I have provided a basic analysis in these comments above by excerpting an analysis found on the net. There are others to chose from or synthesize your own. Refer to this historical EIS section when referencing tables and figures that look backwards in time to give context to the time period under discussion. This section "COMMODITY PRICES" third paragraph, The historical data also show how much variability can occur in commodity prices even over several years. Future commodity prices and price fluctuations are a source of uncertainty in this analysis. The assumption in this analysis is that uranium prices will remain stable at current levels over the 20-year period of analysis. Similarly the estimate of the industrial capacity to maintain six mines in production at any one time is assumed to be primarily driven by uranium commodity prices and will remain similar over the 20-year period of analysis. A degree of variation in commodity prices is expected to occur, but to predict that drastic increases or decreases in uranium commodity prices will occur is considered speculative for this analysis.	See Comment 225279:8
The NAU Project, LLC	242913	11	B.8, any section that has haul trips The haul trips to take uranium ore to the mill will have to be adjust based on the increased uranium resource to be mined as outline in my comments on "Total Estimated Uranium Resources".	The number of haul trips has been modified in the FEIS to reflect greater uranium reserves in known deposits.
The NAU Project, LLC	242913	12	Table B-44, page B-57 Assumptions Used to Develop Reasonably Foreseeable Development Scenarios" Redo any assumptions that my comments for Appendix B pertain to that are found to be valid. Assumptions 3,16, and 17.	The number of haul trips has been modified in the FEIS to reflect greater uranium reserves in known deposits.
Janet Remington	244004	3	What is the acreage of each of the uranium mine claims filed for land in or near the Grand Canyon?	Breccia pipe uranium deposits are generally located by lode mining claims which can be up to a maximum of 20 acres.
Janet Remington	244004	5	What are the names of these individuals or corporations, and if	The purpose of this EIS is to analyze the impacts of

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			corporations, who are the board members?	the Proposed Action and alternatives, which is a withdrawal from the mining law of 1872 of approximately 1 million acres in Northern Arizona and two reduced withdrawal alternatives. Identification of the individuals or corporations holding mining claims isn't relevant to the analysis in this EIS.
Janet Remington	244004	7	How many of the claims to mine uranium in or near the Grand Canyon possessed by other than U.S. citizens or U.S. corporations?	The purpose of this EIS is to analyze the impacts of the Proposed Action and alternatives, which is a withdrawal from the mining law of 1872 of approximately 1 million acres in Northern Arizona and two reduced withdrawal alternatives. An analysis of the nationality of parent companies holding uranium claims isn't relevant to the analysis in this EIS.
Janet Remington	244004	8	Are there any laws or rulings to prevent sales of these claims to non-U.S. citizens?	The purpose of this EIS is to analyze the impacts of the Proposed Action and alternatives, which is a withdrawal from the mining law of 1872 of approximately 1 million acres in Northern Arizona and two reduced withdrawal alternatives. An analysis of the nationality of parent companies holding uranium claims isn't relevant to the analysis in this EIS.
Recreation				
David Thompson	26595	2	Concerns that were inadequately or only partially addressed include the profound spiritual meaning that the Grand Canyon teaches anyone who is fortunate enough to spend time there.	The FEIS includes discussions and analysis on "Sense of Place" in the Stakeholder Values sections of 3.16 and 4.16, Social Conditions. Because a "profound spiritual meaning" is a very personal experience, it would be speculative to attempt to address it in an EIS.
American Whitewater	54357	1	Your analysis failed to consider the impacts that unrestricted or under-restricted uranium mining could have on Grand Canyon river trips. The people on these trips, our members, literally live in the canyon for weeks at a time. They marvel over, drink from, and swim in the Colorado River as well as cherished tributaries like the Little Colorado River, Kanab Creek, and Havasu Creek. Experiencing each of these streams is a vital part of paddling the Grand Canyon, and the water quality and quantity of each is threatened by uranium mining. Failing to consider the very real risks to this incomparable and irreplaceable recreational experience is a massive oversight in the DEIS.	The recreation section of the FEIS includes discussions on potential indirect effects to recreation users in the Grand Canyon Watershed in Section 4.15, Recreation Resources. The analysis included effects on the recreational experience of users throughout the area. Analysis of the potential impacts to water quality of the Colorado River and its' tributaries are discussed in Section 3.4 and 4.4, Water Resources.
American Whitewater	54357	2	Your analysis seeks to quantify the risks of allowing uranium mining near the Grand Canyon. The results of your analysis confirm that the risks of long term water quality and quantity impacts exist that could impact iconic tributaries to the Grand Canyon. We believe that by excluding the Grand Canyon paddling experience from your analysis, including hiking along, swimming in, and drinking from the tributaries, you have miscalculated the	The recreation section of the FEIS includes discussions on potential indirect effects to recreation users in the Grand Canyon Watershed. The analysis included effects on the recreational experience of users throughout the area. Analysis of the potential impacts to water quality of the Colorado River and its'

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			risks of allowing future uranium mining. Radiation and other pollution in these streams would directly impact human health and perceptions of wildness. Even very small reductions in flow in tributaries and springs would impact the experience of these places.	tributaries are discussed in Section 3.4 and 4.4, Water Resources.
Jackie Blumberg	180636	2	The statement in the Executive Summary, page ES-14 within the Impacts to Recreation section, The increase in miles of new mining related roads for all alternatives would benefit driving for pleasure is complete nonsense. No motorists I know of delights in dodging mining related haul traffic, heavy equipment or busloads of miners during a pleasure cruise.	In response to this comment, the FEIS has been revised in the Executive Summary to read: "The increase in miles of new mining-related roads for all alternatives would provide an increase of motorized recreation opportunities, resulting in a benefit to driving for pleasure..." The BLM's Arizona Strip Field Office Resource Management Plan specifies off-highway vehicle use and driving-for-pleasure amongst the most popular recreation experiences in the Planning Area, as discussed in Section 3.15 of the FEIS. All routes are available for public use unless otherwise specified. Mining-related roads would be closed post-mining. Determining the specific preferences for the driving-for-pleasure recreation experience is outside of the scope of this EIS.
American Clean Energy Resources Trust (ACERT)	225256	11	RECREATION Page ES-10 Statement: *Recreation activities occurring throughout the proposed withdrawal area involve a broad spectrum of pursuits, ranging from dispersed and casual recreation to organized, BLM-permitted and Forest Service-permitted group uses. The Arizona Strip is known for its large-scale undeveloped areas and remoteness. Typical recreation in the region includes off-highway vehicle driving, scenic driving, hunting, hiking, wildlife viewing, horseback riding, camping, backpacking, mountain biking, geocaching, picnicking, night-sky viewing, and photography. The area's proximity to the globally recognized Grand Canyon enables large numbers of U.S. residents and foreign visitors to access the public lands conveniently.* This comment seems to be specific to the north parcel. One has to ask if anyone of the preparers of this report has traveled from Highway 389 south on the dirt road to the north boundary of the Grand Canyon. This road is only for the hearty vehicle with heavy duty tires. This is not a bike path nor is it a hiking trail. Many of these roads were put in for mining purposes. They were not reclaimed at the request of the BLM so they would have access to the area. The road to the boundary is neither scenic nor campground material. This is an arid land with sage brush spaced generously due to the lack of water in the area. There are no homes along those roads and only a few cattle here and there. There are some trees but nothing glamorous like a shade tree - mostly taller juniper trees. As for the endangered species of plants on the Strip - the natural process of lack of moisture is a far greater threat than any small mining operation could be. As for all of the other activities listed, you must have confused the withdrawal area with the monuments and	The FEIS recreation discussion is consistent with the recreation settings, experiences and opportunities as they are discussed, evaluated and subsequently managed in the Arizona Strip Field Office Resource Management Plan and Kaibab National Forest Plan.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			wilderness areas in northern Arizona.	
American Clean Energy Resources Trust (ACERT)	225256	106	Pages 4-220 to 4-231 Page 2-43, Table 2.8-1 **Statement: Entire Section** Comment: The attributes that govern recreation settings include "remoteness, degree of human modification to the natural environment, evidence of other users, restrictions and controls on surface disturbing activities, and level of motorized vehicle use. The discussion emphasizes the 5 million people that visit the Grand Canyon, mostly at the South Rim. The areas visited by most visitors at the top of the Rim do not meet many of the attributes listed. These areas are not remote and motor vehicles can drive close to the edge. There are lodges, restaurants, and a number of other facilities along that portion of the Rim. The number of visitors for other activities in the Arizona Strip for 2009 is (Table 3.14-3): It is evident that the most common activity is interpretation, education, and nature study, with 19 visitors per day. Driving for pleasure is the next common activity. The average number of visitors per day is 3.2. If interpretation, education, and nature study were excluded the average would decrease to 1.7 visitors per day. 1. It is clear from the above that the number of visitors on the Arizona Strip on a daily basis is small. With 6 mines at anyone time spread over 1 + million acres in three separate parcels, under Alternative A, the probability of their encountering a mining or exploration site is slight. 2. The main causes of disturbance to recreation seem to be sounds and visual obstructions. As indicated by the analysiS for "soundscapes" (Section 4.10 of the DEIS) the sounds will not be audible beyond 2.5 miles of the activities (with no wind or obstruction). Visual obstruction to the view will also not be likely to occur at that distance, especially if there are trees. 3. Motorized vehicles while driving for pleasure or for OHV travel will themselves create both noise and visual obstruction. Besides they will pass any mining activity in a short time period. It is not clear whether the campers and picnickers arrive in motorized vehicles or not. 4. Hunters will themselves create noise and not want to come close to activities where game may not be present. They have over 3.2 million acres open for hunting, whereas only 68 acres per year would be occupied by mine-related activities. 5. During the period 1956 through1969, while the Orphan Lode was being mined, the number of visitors to the Park steadily increased from 1 million to 2.2 million, according to data from the National Park Service. It was evident that uranium was being mined since the headframe was clearly visible at the rim of the Grand Canyon and no attempt was made to conceal the mineral being extracted. Again when the uranium mines were operational, 1980 through 1991, the number of visitors to the Grand Canyon National Park grew from 2.3 million to 3.9 million. So tourism to the Park was not impacted during each of those periods. 6. It should also be borne in mind that each new mine would be the subject of its own sitespecific EIS and the NEPA process and strict scrutiny.	Analysis of mining effects on visitation n the Grand Canyon National Park is in EIS Section 4.15. In addition, information has been added to Section 4.15, Recreation Resources that specifies the difference of the recreation settings offered by the South Parcel as compared to the North and East Parcel. Approval of a mining plan of operation(s) is a subsequent decision and will include separate, site-specific NEPA analysis which would further address any potential to impact recreation resources. The environmental analysis of the proposed withdrawal in this EIS presents overall impacts to recreation as it applies to all three parcels.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Social Conditions				
Albert Hale	213921	3	The DEIS should acknowledge that implementing Alternative A will cause significant impacts to Navajo people because it will result in " Disproportionately high and adverse environmental health impacts to an identified minority or low-income population that appreciably exceed those to the general population around the project area" (DEIS, p. 4-232).	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology; the revised analysis in the FEIS no longer includes a comparison to non environmental justice communities. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in "Stakeholder Values." The history of adverse health outcomes and increased cancers in the Navajo miners are beyond the scope of the EIS, as discussed in Stakeholder Values (see Section 3.15 of the DEIS). The revised environmental justice analysis in the FEIS thoroughly addresses cumulative impacts to the tribes in the study area, and other low-income or minority communities in or near the area proposed for withdrawal, as required by law and the Executive Order.
		4	The DEIS is deficent when it fails to take into account the legacy of harm and cumulative impacts caused by past uranium activities near Navajo communities in its assessment of environmental injustice impacts (DEIS, p. 4-239). It concludes that "there are other non-environment justice communities within the study area that could be exposed to the same healh risks; therefor, these effects are not expected to be disproportionate. To tribal environmental justice communities." Non-tribal communities, such as St. George, Ordervill, and Hildale cited in th DEIS, and non-environmental justice communities have been unaffected by serverall decades of uranium mining that occurred on Navajo lands, beginning in the 1950s. Unlike Navajo communities, thar are not currently suffering from the pre-existing cumulative impacts of past uranium activiies. Navajo people will therefore be disproportionally affected by the cumulative impacts of new uranium mining. The National Environmental Policy Act requires the consideration of "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency undertakes such other activities" [40 CFR 1508.7]	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology; the revised analysis in the FEIS no longer includes a comparison to non environmental justice communities. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in "Stakeholder Values." The history of adverse health outcomes and increased cancers in the Navajo miners are beyond the scope of the EIS, as discussed in Stakeholder Values (see Section 3.15 of the DEIS). The revised environmental justice analysis in the FEIS thoroughly addresses cumulative impacts to the tribes in the study area, and other low-income or minority communities in or near the area proposed for withdrawal, as required by law and the Executive Order.
Adam Shapiro	40305	2	anyone except miners. This does not reflect the scope of current scientific understanding. It cites a body of scientific research that depends on flawed logic. Studies have indeed shown that depleted uranium (DU) can cause cancer (i.e. Miller, A. C., et al. Observation of radiation-specific damage in human cells exposed to depleted uranium: Dicentric frequency and neoplastic transformation as endpoints. Radiol. Protection Dosimetry 99(14):275, 278, 2002). Studies also show that the toxicity and the radioactivity of DU amplify its effects so that over eight times as many cells	The FEIS has been changed to further emphasize that there is currently a lack of understanding as to the cause and effects of uranium exposure and cancer in humans. A discussion of depleted uranium is considered relevant, and is included in the EIS in Section 3.16, because the paucity of studies of natural uranium effects on humans requires that the much more

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			suffer cytogenic damage (i.e Royal Society (U.K.). The Health Effects of Depleted Uranium Munitions, Parts I and II. London, May 2001 and March 2002, and Miller, A. C., et al. Potential late health effects of depleted uranium and tungsten used in armor-piercing munitions: Comparison of neoplastic transformation and genotoxicity with the known carcinogen nickel. In Proceedings of the International Conference on Low-Level Radiation Injury and Medical Countermeasures, ed. T. M. Blakely et al. Bethesda, MD, November 810, 1999; reported in Military Med. 167(2): 120122, 2002). The logic of many medical studies cited in the DEIS is flawed (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010). These sources are used to support the claim that a direct link cannot be shown between uranium mining and cancer because miners expose themselves to other carcinogens. Just because there is no way to say that a certain case of cancer is due to any one factor does not mean that exposure to radioactive chemicals does not itself pose a significant threat to human health. The logic used in the DEIS is similar to the logic in the following statement, "James is picked on by his peers, is abused by his parents, and has untreated medical conditions. We are denying him services because his mental health issues are not clearly a result of any one of these conditions." This logic has a place in scientific research, but not in a report on potential health impacts on humans.	studied effects of DU is used as a surrogate for estimating those effects. Section 4.16.2, "Incomplete or Unavailable Information" has been added to the FEIS further clarify this information. In the paper cited (Miller et al. 2002) the authors demonstrate that depleted uranium (DU) at relatively high levels can cause cellular transformation. In the paper, Miller et al. (2002) used a human osteoblast immortalized cell line to study the effects of uranium and found that the cells were transformed and had DNA damage. However, cellular transformation, while indicative of the ability of a compound to alter cells and damage DNA, is only part of identifying a carcinogen. Further studies need to be conducted in humans to determine to what degree uranium causes increases in osteosarcomas.
Hopi Tribe	213932	2	*Hopisinom* and many other Native American people suffer an ongoing legacy of death by cancer, chronic health problems, and radioactive contamination including water contamination on tribal lands. The legacy of uranium mining has devastated the people and the land, and the 1872 mining law continues to destroy the land and lives of *Hopisinom*, Native Americans, and Americans alike.	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology.
Kaibab Band of Paiute Indians	246166	2	The Recreation Resource category appears not to have considered the increased risks to safety for impacts from mining haul trucks on roads other than Highway 64.	Human health and safety is discussed and analyzed under Social Conditions in the DEIS. The recreation resources sections, in regard to haul routes, discuss the experiences, opportunity, and settings of the routes, not the risks to safety. The analysis does, however, recognize the potential impact increases in mining haul trucks would have on recreation resources. As stated in the DEIS, Section 4.14.3, Impacts of Alternative A: No Action, "The increase in activity associated with 30 new mines, increases in heavy-haul trucks, increase in noise, and 22.4 miles of new roads could affect the recreational experience, although the impact would be minor." The DEIS includes a comprehensive listing of existing roads that would be used for haul routes for each proposed withdrawal parcel, including State Highway 64, in 3.15,

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Social Conditions, under the 'Transportation Conflicts' section. These conflicts are analyzed in Section 4.16, Social Conditions, in the FEIS.
Sustainable Economic Development Initiative	54353	5	There are several important negative impacts of these accidents not considered in the DEIS, including the economic and social safety impacts of accidents, injuries, and deaths. Beyond the economic impact from access route closures and delays, 367 accidents, causing 151 injuries and 4 deaths would have significant direct and indirect economic and social safety impacts on the region. Although these impacts are difficult to quantify because of the unknown severity of each accidents and injury, and the unknown lost income for the wide range of potential accident victims and their families, these impacts would be significant.	The Transportation Conflicts discussion in Section 3.16 and 4.16 of the FEIS has been updated based on new information provided by the public and using a more refined methodology based on risk frequency calculations for hazardous material transportation (U.S. Department of Transportation [USDOT] 2007).
Herbert Alexander	54361	2	At a recent meeting of the Kanab City Council, the higher cost of health insurance for city employees, six of whom are suffering from the effects related to air born radiation, was discussed. Because we are considered "Down Winder's" from the effects of being downwind of previous nuclear testing in Nevada, insurance carriers charge us a higher premium. Has this problem been taken into consideration by your team? If so, what conclusions did you come to, and why?	The DEIS includes an analysis of potential impacts to air quality (see Sections 3.2 and 4.2 of the DEIS). If a future, specific mine is proposed, a separate site specific analysis would evaluate potential dispersion impacts from a particular source and destination. Additionally, the potential human health impacts from exposure to uranium are discussed in the EIS (see "Public Health and Safety" in Sections 3.16 and 4.16 of the DEIS). The higher cost of insurance charged to "down winders" has not been considered in the FEIS because neither extraction and hauling of uranium ore, nor withdrawal of the area from the mining law is expected to have any effect on the cost of insurance premiums.
Herbert Alexander	54361	4	As there will be many trucks loaded with radioactive material and driving through radioactive dust at the loading point traveling through the heart of Kanab, what studies did you do about contamination of trucks before they leave the mine and the processing plant. Also, as trucks will be stopped at the red light in town and will be in close contact with buildings and pedestrians, are there systems in place to minitor radiation there and other places in the city and on public roads. As has been noted repeatedly on the news since the Japan crisis, no amount of radiation is safe.	Ore is transported by haul trucks from the mine to the mill. The haul trucks are designed such that the material being transported is covered in such a way that the ore being hauled is controlled/mitigated and not allowed to escape the vehicle as a fugitive source. The Transportation Conflicts discussion in Section 3.15 and 4.15 of the FEIS has been updated based on new information provided by the public and using a more refined methodology, including estimates of exposure of the public from transportation shipments containing uranium ore. Although there is no regulatory requirement for radiation monitoring along haul routes, many mining companies voluntarily conduct gamma monitoring. A summary of monitoring data from the Arizona 1 Mine is included in the FEIS.
Adam Shapiro	104131	1	The DEIS ignores the intent of the concept of environmental justice by	The Environmental Justice discussion in the FEIS has

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			stating that potential impacts from mining would effect minority and poor populations as well as other people, so there is no environmental injustice (p. 4-239). Any impacts on drinking water, health issues, etc. would absolutely have a disproportionate effect on poor or minority communities. Wealthy people have greater ability to move away. Non-indigenous people have the ability to move away without leaving their culture and homeland. Please acknowledge that any mining has the real potential to create environmental injustice.	been updated based on new information provided by the public and using a more refined methodology.
Noel Poe	106647	3	Reclamation of roads and site development. The discussion made about reclamation of surface disturbing mining activities on pages 3-245, 4-103, 4-223, etc. gloss over the difficulty of reclaiming man-made disturbances in the desert. There are statements that disturbed areas would be returned to a natural condition or such areas would be reclaimed to insure ground surface integrity is not compromised. The former is not possible and the latter is not sufficient. In addition on page 4-222, mine roads are listed as having a short term impact because they exist less than 5 years. However elsewhere in the document a statement is made that the average life of mining activities at a site is 6 years. If one looks at the figures in the USGS Legacy Report it is obvious that 10 or even 20 years of reclamation efforts have not reclaimed roads or mine sites. See Figures 5, 8, 18, and others.	Reclamation requirements are specified on a case-by-case basis. Further information has been added to Section 4.3.3 discussing what has been required historically and what is in current proposed plans of operation. Appropriate mitigation for future mining activity, including required reclamation standards, would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. In addition, State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Kanab Utah	225250	6	The EIS list of preparers includes 52 entities, none of whom demonstrate skills in assessing social and economic impacts on local communities. In fact, the preparers are predominantly from agencies whose missions and training would lend them to a bias against resource development to provide social and economic benefit to such communities. By refusing to include preparers with an understanding of such impacts, the recommendations are biased by definition.	BLM contracted with an economist to assist in analyzing and responding to comments on the DEIS and refining the analysis for the FEIS (see Section 5.6, List of Preparers). In terms of the social aspects of the analysis, several staff on the team, both at the BLM and their consultant (SWCA), are experienced in evaluating social impacts, including anthropology and sociology.
Donald Begalke	225254	5	I respectively request the BLM to insert another transportation road map in this Draft regarding the additional "thousands of new mining claims" which caused this proposed withdrawal project.	Since the publication of the proposed withdrawal in the *Federal Register* on July 21, 2009, no new mining claims have been located in the area, and many have lapsed due to non-payment of assessment fees. The current number of claims within the proposed withdrawal area (as of July 15, 2011) is approximately 3,350. A map of project mining claims will not be included in the FEIS; however, current mining claim information is available on the BLM's LR2000 system (http://www.blm.gov/lr2000/). The Mining Claim Recordation (MC) section contains information on unpatented mining claims located on federal lands within the area proposed for withdrawal. Using the legal descriptions in Appendix C of the Final EIS, the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				number and location of claims can be extracted from LR 2000.
		10	Recreationists, too, are affected by unreclaimed mineral-explorations' failures. What are the safety standards by the agencies to protect human healths in the parceled areas under withdrawal discussion? Not in this Draft?	The EIS includes an analysis of potential impacts to human health both to miners and area recreationists (see Sections 3.16 and 4.16, "Human Safety Risks"). Each mining operation has a Reclamation Plan as a part of the approved Mining Plan of Operations. As discussed in Section 2.4.2 of the EIS, "The operator is required to provide the BLM with an approved financial guarantee that is adequate to cover the estimated cost to complete the reclamation plan before beginning activities under either a notice or plan of operations." Reclamation standards are based on site conditions and are developed when site-specific NEPA is conducted during processing of a mine plan of operations.
American Clean Energy Resources Trust (ACERT)	225256	12	SOCIAL CONDITIONS Page ES-10 Statement: *Other than a handful of towns and cities in each county, the study area is relatively remote and sparsely populated. Population centers in Coconino and Mohave counties are generally located south of the proposed withdrawal area.* Comment: Compared to Flagstaff, Arizona, Kanab, Utah and Fredonia, Arizona may appear "sparsely populated". However, both communities are gateway communities for travelers going south from St. George, Utah or Page, Arizona. These communities lost a significant number of residents due to the mining shut down in the early 90s.	The FEIS includes an updated description of the study area and better clarification of population density.
American Clean Energy Resources Trust (ACERT)	225256	49	Page 3-233 Statement: *Communities profiled in this section were methodically selected for analysis based on two criteria: 1) they are located within 50 linear miles of the boundary of the proposed withdrawal parcels; and ...* Comment: What is "methodical" about drawing a 50-mile boundary around the proposed withdrawal parcels? The word "arbitrarily" should replace the word "methodically". If, as you claim in an earlier paragraph, "the study area is relatively remote and sparsely populated", you should be aware that 50 miles is a short distance to travel to work, shop or trade. You included San Juan County, Utah, among the five counties most likely to be affected by the proposed withdrawal although it is outside the 50-mile radius, but you failed to include Garfield County, Utah, because it is outside your capricious restriction.	The FEIS includes an updated description of the study area; additionally Garfield County has been added to the analysis in Sections 3.16, 4.16, 3.17 and 4.17. Please note that the methodology described in the DEIS is intended to provide a snapshot of the demographic characteristics of the area for which data exist.
American Clean Energy Resources Trust (ACERT)	225256	50	Statement: *Blanding, Utah, is discussed specifically because it is the major uranium processing center in the region (White Mesa Uranium Mill).* Comment: You violate your 50-mile rule and include San Juan County as an affected county because it contains Denison Mines' uranium mill and, yet you fail to mention (here or anywhere in the DEIS) Uranium One's Shootaring Canyon Uranium Mill near Ticaboo in Garfield County, Utah.	Per Section 1.5.3 (Issues Eliminated from Detailed Analysis) of the DEIS, "alternate locations besides the White Mesa Mill in Blanding, Utah, in which mined uranium should or should not be processed, stored or sold." Rationale for issues eliminated has been added to the FEIS in Section 1.5.3.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			While the mill presently lies idle because Secretary Salazar's segregation order of July, 2009, effectively stopped all exploration and consequent discoveries, Uranium One officials have repeatedly stated their desire to reopen the mill when they and the rest of the uranium mining industry are allowed to resume exploration and mining within the segregated area. The DEIS's denial of the existence of Shootaring canyon Uranium Mill is inexcusable, as is Garfield County's exclusion from affected county status.	
American Clean Energy Resources Trust (ACERT)	225256	51	3.15.1 SOCIAL CONDITIONS: AREA COMMUNITIES Page3·236 Statement: *Many area communities that have access to federal lands (such as BLM, Forest Service, and NPS lands) have strong ties to these lands; residents can form a strong sense of identity based on the cultural and geographic nature of the area. Communities like St. George, Colorado City, Fredonia, Page, and Williams exist in relative isolation, whereas communities like Flagstaff have more of a tourism focus and are close to, and benefit more directly from, each area's unique resources.* Comment: The EIS says St George, Fredonia, Page exist in isolation and do not have as much a tourism base as Flagstaff and that Flagstaff benefits from local resources much more than other towns in the withdrawal area. This is not true. Because it is at the junction of routes 1-40 and 1-17 Flagstaff receives considerable tourist traffic from people who are not intending to visit local attractions, but merely need a place to stay while passing through, or are in some way connected with Northern Arizona University. St George is very much a tourist town due to its mild climate, scenery, and proximity to natural attractions such as Zion, Bryce Canyon, the Grand Canyon-Parashant National Monument, the Grand Canyon, the Grand Wash Cliffs Wilderness, the Beaver Dam Mountains Wilderness, the Mount Logan Wilderness, the Mount Trumbull Wilderness, and the Paiute Wilderness. In addition it has many very good golf courses. Many people move to St George for their retirement. Page Arizona, attracts many tourists because of Lake Powell and the Glen Canyon National Recreation Area. The Kanab-Fredonia area attracts many tourists because of its proximity to Zion, Bryce Canyon, the North Rim, the Grand Canyon, the Grand Staircase-Escalante National Monument, and Best Friends Animal Shelter. To say that Flagstaff benefits more from local resources than other towns in the area of the proposed withdrawal is illogical, incorrect and needs to be corrected	The FEIS (Section 3.16.1) has been updated based on direct input from the counties in Utah and Arizona, including information in local land use and economic development plans.
American Clean Energy Resources Trust (ACERT)	225256	52	Pages 3-242 thru 3-246 Comment: This section is misleading. This section very well may have been written by one of the radical environmental groups, as it appears to try to distort facts to show something which they don't show. Examples of this are: (1) Kidney disease: Any metal is toxic if ingested into the human body in great enough quantities in certain chemical states. The amount of uranium taken into the body by a person working in a uranium mine is not nearly enough to cause kidney problems. (2) Lung toxicity: The extremely small amount of uranium mineral dust	The intent of the EIS is to estimate and disclose the affects of the proposed action and alternatives. Comparisons with other potentially hazardous activities, while interesting, is not relevant to the disclosure of impacts of this EIS. The section on potential hazard was written by Dr. Clark Lantz (see Table 5.3-1 of the DEIS), an environmental health expert at the University of Arizona, Southwest

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			which might enter the lungs is not nearly enough to have sufficient radioactivity from uranium or its daughter products to be even remotely likely to cause cancer. Respiratory problems can result from inhaling solid particles of a great variety of substances into the lungs and this is not restricted to uranium mines, but can be a hazard in many occupations. Construction workers, heavy equipment operators, coal miners, and farmers are also exposed to this hazard, often to a much greater extent than uranium miners. Uranium mines have a high volume of air ventilating them, and are tested for airborne particulates and radon on a continuing basis . . Respirators and dust masks are available to the miners at all times. Limits for radon and dust are set by federal agencies with heavy penalties for violations This section needs to be revised to reflect actual conditions in uranium mines and not the contrived and non-existent situations described in the EIS.	Environmental Health Science Center, of which he has been a director since 2000.
American Clean Energy Resources Trust (ACERT)	225256	53	Pages 3-242, 3-243 depleted uranium One of the Statements: *The discussion of potential health risks associated with uranium mining that follows is based primarily on a 1999 report on the chemistry and toxicological effects of natural and depleted uranium (Craft et al. 2004), a report from the Agency for Toxic Substances and Disease Registry (1999), and from Technical Fact Sheets on Radionuclides (Argonne National Laboratory 2005; EPA 2000, 2010m)* Comment: This section repeatedly mentions depleted uranium and some of its risks. The chemical properties of depleted uranium are essentially the same as those of any other combination ofthe isotopes of uranium, including natural uranium. There is not even a remote chance that depleted uranium would be encountered in mining, as it is an artificially created substance. Continually mentioning it in the discussion is misleading, distracting, and makes the document appear unprofessional. Depleted uranium as it normally exists is in a chemical state not encountered with natural uranium minerals. References to depleted uranium should be deleted.	This section was written by Dr. Clark Lantz (see Table 5.3-1 of the DEIS), an environmental health expert at the University of Arizona, Southwest Environmental Health Science Center, of which he has been a director since 2000. A discussion of depleted uranium is considered relevant, and is included in the FEIS (as it appears in the DEIS in Section 3.15) because the paucity of studies of natural uranium effects on humans requires that the much more studied effects of DU is used as a surrogate for estimating those effects. This is not to imply that miners would be exposed to depleted uranium but rather since more is known about health effects from exposure to depleted uranium it is used here to help fill in gaps of knowledge related to expected adverse health outcomes in miners from exposure to natural uranium. As discussed in the FEIS, natural uranium is more radioactive and may cause more health effects that depleted uranium. Section 4.16.2, "Incomplete or Unavailable Information" has been added to the FEIS further clarify this information.
American Clean Energy Resources Trust (ACERT)	225256	54	Page 3-246 Statement: Entire section Comment: It is extremely unlikely that any company would want to haul ore through Flagstaff or any of the communities on 1-40, use 1-40, Route 191 (except from Mexican Water to Blanding), Route 64 from Tusayan toward Cameron (it is certain the Park Service would not permit it), or to haul ore through Tusayan. Even with 5 mines working, resulting in 30 truck trips per day, and considering the least used Route 191, this would cause an increase of 3% in traffic, which would not be noticeable. Also, many of the trips would be at night when there would be almost no other traffic. Putting the factual effects of ore hauling	The Transportation Conflicts discussion in Section 3.16 and 4.16 of the FEIS has been updated based on new information provided by the public and using a more refined methodology, including estimates of exposure of the public from transportation shipments containing uranium ore and existing vs. projected traffic conditions.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			into perspective should be included in the data, such as percent increase in traffic on the various roads as a result of ore hauling. During the period of mining (1980 -1991), Energy Fuels mined over 1.47 million tons of ore on the Arizona Strip. At 25 tons of ore per truck, there were 58,800 truckloads transported to the mill in Blanding, Utah, a 300-mile one way trip. These trucks traveled a total of 17,640,000 miles with only five ore spills. There were no injuries and all of the spills were cleaned up immediately, surveyed radiometrically and resulted in no harm to the environment. This nearly flawless record proves that uranium ore transportation has been and will be accomplished safely.	
American Clean Energy Resources Trust (ACERT)	225256	55	Page 3-247 Statement: *Based on the criteria presented above, there are 10 communities in the study area in which the minority population exceeds 50%, based on 2000 Census data: Bitter Springs, the Havasupai Indian Reservation, Hopi Tribe, and Tuba City, and the Navajo Nation in Coconino County; the Kaibab Reservation (Kaibab Band of Paiutes), Kaibab Census DeSignated Place (COP), and Hualapai Tribe in Mohave County, and Navajo Mountain in San Juan County (see Table 3.15-2). Kayenta in Navajo County is also considered a minority community using criteria listed above.* Comment: While these communities may in fact be considered minority communities using the stated criteria, inclusion in this report is inappropriate as many are not in the so-called "study area" or withdrawal area. It has been noted that the definition of "study area" changes throughout this report depending on how much the writers want to increase the perception of a threat of uranium mining in the area. Please remove the Hopi Tribe (they are in the middle of the Navajo Reservation and not even close to the withdrawal area), Tuba City, the Navajo Nation, Hualapai Tribe in Mohave County, Navajo Mountain and Kayenta. This section must be corrected. And, as stated earlier in this document, there are many, many errors in this section and if stated, it would take page after page to list them all. Please review this entire section on social conditions and correct all of the glaring errors, inconsistencies and inappropriate inclusions.	The study area has been revised in the FEIS to include communities more likely to be affected by the proposed alternatives than others. The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology. Additionally, a statement of clarity has been added regarding the physical proximity of the Navajo Nation, Kaibab Reservation, and Hualapai Reservation.
American Clean Energy Resources Trust (ACERT)	225256	140	Increase in daily traffic is also a matter of concern, although this would only increase by 0.012% on roads such as US 191 or US 160.	The EIS discusses potential transportation conflicts with changes in traffic (see Section 4.16, "Human Safety Risks," "Transportation Conflicts"). The Transportation Conflicts discussion in Section 3.16 and 4.16 of the FEIS has been updated based on new information provided by the public and using a more refined methodology, including estimates of exposure of the public from transportation shipments containing uranium ore and existing vs. projected traffic conditions.
American Clean Energy	225256	142	Environmental Justice None of the nine environmental justice communities within the withdrawal-affected area would experience risks	The Environmental Justice discussion in the FEIS has been updated based on new information provided by

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Resources Trust (ACERT)			disproportionately larger than those to non-environmental justice communities.	the public and using a more refined methodology.
American Clean Energy Resources Trust (ACERT)	225256	143	1. All mines must comply with MSHA standards which include a ventilation plan and monitoring of radon levels. 2. It is evident from the above that the health hazards associated with uranium mining are exaggerated. There is little harm to either the miners or the nearby communities. 3. Uranium is being mined in Canada, Australia, other US states (Wyoming, Colorado, Texas), and various locations in the world and there is sufficient experience to do so safely. There have been no reports of health or safety problems in any of these places. 4. The above discussion shows that withdrawal of 1+ million acres of land under Alternative B, or even the lesser amounts under Alternatives C and D, is not justified. 5. The DEIS assumes that since there will be increased traffic on the roads the number of accidents will increase. Actually with the better technology now available, accidents will likely decrease. The rate of accidents on US highways has gone down over the last decade in spite of the increase in traffic.	The DEIS discusses the roles of MSHA regulations in maintaining safety and health standards (see page 3-242). The health risks discussed in "Public Health and Safety" are based on the professional expertise of Dr. Clark Lantz (see Table 5.3-1 of the DEIS). The Transportation Conflicts discussion in Section 3.16 and 4.16 of the FEIS has been updated based on new information provided by the public and using a more refined methodology.
Energy Fuels Resources	225260	30	Section 4.15.3: The second paragraph on page 4-240 states that there would be no impact on employment at the White Mesa Mill if Alternative B is adopted. We believe that the statement by a Denison employee was probably taken out of context. The fact of the matter is that if the mill does not have an adequate amount of ore at a sufficiently high grade, it cannot run economically and it is shut down, resulting in large layoffs. The higher grade ore found on the Strip is an important asset during downturns in the uranium market, as it has allowed the White Mesa Mill to continue operating in the past when other mills had to shut down.	As discussed in the RFD, all uranium mined from both the North Study Area and the South Study Area is anticipated to be milled at the White Mesa Mill, located in the North Study Area. All alternatives considered in the EIS include some level of additional uranium mining activity, beyond current activity (see RFD, Appendix B). The White Mesa Mill is able to operate under current conditions and with the current level of mineral activity, therefore none of the alternatives are expected to affect the ability of the mill to continue operating. The social and economic analyses have been revised in the FEIS to more clearly discuss the current conditions and potential impacts (see Sections 3.16, 3.17, 4.16 and 4.17).
Uranium Watch	225262	12	The whole history of uranium mining is a story of disregard for human health and wellbeing and a disregard of the impacts to the environment. The DEIS assumes that such disregard is no longer present in the regulatory decision making process. That is clearly not the case. There will continue to be unacceptable risks and impacts from uranium mining, along with an inability of the regulatory agencies to fulfill their responsibilities to protect human health and the environment.	The DEIS discusses how past experiences with uranium mining, specifically the Navajo Nation, influence people's opinions about mining activity; see "Stakeholder Values," in Section 3.15. For the purposes of this analysis, we assume that the regulations in place (see Chapter 1 of the DEIS, Section 1.4.3, "Authorities") are effective and enforceable.
Uranium Watch	225262	34	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The DEIS discussion of Impacts Common to All Alternatives (Section 4.2.4, page 4-16) manages to totally ignore the radioactive and hazardous constituents of any fugitive dust from the mining operation. The EIS must identify all	The DEIS includes an analysis of potential impacts to air quality (see Sections 3.2 and 4.2 of the DEIS). If a future, specific mine is proposed, a separate site specific analysis would evaluate potential dispersion

Table 5.6-4. Response to Comments (Continued)

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			hazardous radioactive and non-radioactive constituents of fugitive dust from the uranium mining operations and assess their impact on the environment. This would include an evaluation of potential exposure pathways and impacts to the public, workers, ground and surface water, soils, vegetation, and native and domestic animals—over the short and long term.	impacts (see Section 4.2.2 of the DEIS). Additionally, the potential human health impacts from exposure to uranium are discussed in the DEIS (see "Public Health and Safety" in Section 4.15 of the DEIS).
Uranium Watch	225262	83	The discussion of Demographics (Section 4.15.2 page 4-234) states: *Mining activity is not expected to increase the burden on area infrastructure.* The operation of uranium mines would have an impact on local emergency responders, who will be called upon to respond in case of an accident or emergency at the mine. Although the mine owners and operators are required to have an emergency response team available, those teams often are located at a greater distance than local responders. At Denison Mines' uranium mines in La Sal, Utah, there have been a number of instances when local emergency responders have been called upon to respond to an accident. This has an adverse impact on the responders because they are not trained to respond to mine accidents and are not given the equipment and guidance underground to assure their health and safety.	The FEIS indicates that area communities have the infrastructure capacity to handle the potential increases in population associated with project alternatives (see Section 4.16, "Demographics"). Information has been added to the FEIS discussing MSHA's mine rescue requirements (see "Health Risks" in Section 3.16).
Uranium Watch	225262	84	The discussion of Stakeholder Values (page 4-234) should include another stakeholder - the stakeholder who wants uranium mining activities to be in compliance with state and federal regulations and wants improvements in the regulations and their implementation and enforcement. Currently and historically, the mine owners and operators and regulatory agencies have not complied with a number state and federal regulations. This includes lack of compliance with the Clean Air Act, the National Environmental Policy Act, and Mine Safety statutes and their implementing regulations. There have been no changes in many of the laws and regulations applicable to uranium mines over the past 20 years. Many of the mining regulations do not specifically address with unique issues associated with uranium mining, such as the emission of radon and other radionuclides from the surface operation.	NEPA impact analyses are not done under the assumption that a mining company--or any other entity--would operate in violation of existing laws. NEPA analysis is conducted on the actions authorized by the agency. There are standards for radon emission issued through EPA regulation and controlled by EPA permit. It is the responsibility of federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary.
Uranium Watch	225262	85	In the discussion of Public Health and Safety (page 4-235) the EIS should recognize that uranium mine operators and in particular Denison Mines has a history of noncompliance with MSHA regulations. The more mines that operate, the more accidents will occur	NEPA impact analyses are not done under the assumption that a mining company--or any other entity--would operate in violation of existing laws. NEPA analysis is conducted on the actions authorized by the agency. It is the responsibility of federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary.
Uranium Watch	225262	86	The discussion of Health and Safety Risks (page 4-236) tries to minimize the potential health and safety risks associated with uranium mining. Thousands of people have been exposed to uranium, radon, radon	The history of adverse health outcomes and increased cancers in the Navajo miners are beyond the scope of the EIS, as discussed in Stakeholder Values (see

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			progeny and other radionuclides from uranium mining milling. However, most of those who have been exposed have never been studied. The impacts of uranium mining to Navajo miners is well known, yet most Navajo people do not smoke, so the DEIS's focus on adverse health impacts from radon only in association with smoking ignores this group of people. There have been a number of adverse health impacts to the people who worked at uranium mines, their families, and citizens who lived in the vicinity of the mines. There have been no studies of the health impacts to the families of mine workers.	Section 3.15 of the DEIS). However, the legacy and source of these increased cancers is more likely exposure to radon without adequate inhalation protection and not exposure to uranium. This can be seen with reports that mill workers did not develop the increased levels of cancer associated with the mining process. The FEIS has been revised to further clarify the differences between the legacy of mining practices in terms of health impacts.
Uranium Watch	225262	87	The EIS must recognize the failure of government agencies to adequately study the impacts of uranium mining and milling on the health of the workers, their families, and surrounding communities. Additional studies are needed, as there is ample evidence of extensive health impacts from uranium mining.	Impacts to human health and safety are included in EIS Section 4.16.
Uranium Watch	225262	88	The discussion of Radon (page 4-227) states that *all mines would comply with MSHA standards, including a ventilation plan and monitoring of radon levels.*There is no way to know if all the mines would comply with MSHA standards. The mines would be subject to MSHA standards, but compliance is another matter. The inspection information and inspection reports for the Beaver Shaft (owned and operated by Denison Mines) and the Pandora Mine (owned by Denison Mines, operated by Reliance Resources) clearly shows that these mines have not been in compliance with MSHA standards and regulations associated with the exposure to underground workers to radon on a number of occasions. Denison Mines was fined $7,699 in 2010 and $2,628 in 2011 for a total of 11 violations associated with protection of workers from radon. Reliance Resources was fined $10,744 in 2011 for 5 violations associated with protection of workers from radon. Will anyone follow the health of those workers over their lifetimes?	The FEIS has been revised to reflect language in Chapter 3.16 to indicate that all mine operations are required to comply with stringent safety and health standards administered by the MSHA. NEPA impact analyses are not done under the assumption that a mining company--or any other entity--would operate in violation of existing laws. NEPA analysis is conducted on the actions authorized by the agency. It is the responsibility of those federal, state, and municipal agencies having regulatory authority to ensure operations are monitored and to enforce existing law where necessary.
Uranium Watch	225262	89	The DEIS should discuss the fact that the ore of the breccia pipes is richer than that of most conventional uranium mining operations, so that the potential for worker over exposure to radon is greater.	The legacy and source of increased cancers is more likely exposure to radon without adequate inhalation protection and not exposure to uranium. This can be seen with reports that mill worker did not develop the increased levels of cancer associated with the mining process. In addition, mine workers are required to wear dosimeter badges that detect the limits of safe radiation exposure. The FEIS has been revised to further clarify the differences between the legacy of mining practices in terms of health impacts.
Uranium Watch	225262	90	The discussion of Radon (page 4-227) does not mention the exposure to the public from radon from the underground mine workings. Radon and radon progeny is emitted from the underground mine at the portals and mine vents. Since the uranium mines in the withdrawal area will mine less	The Arizona 1 mine and others in the withdrawal area have been required to acquire air quality permits from the ADEQ; the EPA has delegated authority to the ADEQ to administer and enforce the Clean Air Act. Per

Table 5.6-4. Response to Comments (Continued)

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			than 100,000 tons over the life of the mines, the radon emissions will not have to be monitored, and the mine owner will not have to submit an application to the EPA and receive approval of their plan to construct or modify the mine as a radon source, will not have to calculate the exposure to the nearest receptor, will not have to comply with the EPA radon emission standard, and will not have to submit annual compliance reports.14	CFR Part 61 Subpart B, if a mine exceeds 100,000 tons of ore production per year or over the life of the mine, the mine is required to comply with radon emission regulations. However, they are still required to apply for an air quality permit, which would require review of the project plan. The legacy and source of increased cancers is more likely exposure to radon without adequate inhalation protection and not exposure to uranium. This can be seen with reports that mill worker did not develop the increased levels of cancer associated with the mining process. The FEIS has been revised to further clarify the differences between the legacy of mining practices in terms of health impacts.
Uranium Watch	225262	91	The DEIS should have discussed the emission of radon from the vents and the potential for members of the public to be exposed to radon in the vicinity of the mining operation. Normally, mine vents are not fenced or marked with a sign warning the public that radon, a federally regulated hazardous air pollutant, is being emitted. Near the La Sal mines, there is a vent that does not have a diffuser. A member of the public can sit or stand on the vent and be exposed to radon, without any warning. Members of the public can approach other vent, which are on public land, and be exposed to radon without their knowledge	The vents associated with breccia pipe mines are typically within the mine area proper, fenced from public access and far enough from the fence for radon to disperse to safe levels before reaching the fence. Since the EIS is not intended to analyze or authorize any particular mine but rather to estimate the effects of withdrawal from mining, impacts are based on typical mine design. When a new mine is proposed, a NEPA analysis will be conducted on the site specific design in a Mine Plan of Operations.
Uranium Watch	225262	92	The discussion of Ingestion of Wildlife Exposed to Uranium (page 4-238) should have included an assessment of the possible exposure of wildlife to other radionuclides from the mining operation in addition to uranium. Wildlife would be exposed to radon and radon progeny from the emission of radon and radon progeny and the decay of radon that is emitted from the mines. Radon and radon progeny would be dispersed over a large area, though concentrated near the mine and mine vents, providing a potential for wildlife to ingest and inhale radon progeny. If humans and other animals ingest exposed animals, there would be an additional impact.	Section 4.7 has been updated to add more depth to the discussion on emission of radon and radon progeny,
Uranium Watch	225262	93	The discussion of Environmental Justice (page 4-239) fails to include the White Mesa Band of the Ute Mountain Ute Tribe. The White Mesa tribal community bears the brunt of the impacts from the processing of the ore from the withdrawal area. If the mill did not exist, the ore would not be mined, because there is no other operating uranium mill in the vicinity of the withdrawal area and the currently operating and proposed mines are owned by Denison Mines, the owner of the Mill. There is a direct relationship between the mining or the uranium ore in the withdrawal area and the processing of the ore and disposal of the tailings on White Mesa. There has never been a consideration of the disproportionate impacts from	An environmental report was required by the State of Utah for licensing of the White Mesa Mill. To the extent the analysis of these impacts may have been required in the permitting process, they would have been addressed. Because the mill is expected to remain within the existing permitted capacity under all of the alternatives analyzed in this EIS, operations at the mill are not considered a connected action to the proposed withdrawal, so are beyond the scope of this EIS. Any proposed expansion of the Mill onto federal

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			uranium mining and milling to that community. There are no communities that are similarly impacted by the operation of the White Mesa Mill. The health risks, exposure to chemical and radioactive emissions from the Mill, and impact to water, wildlife, domestic animals, and plant life all fall disproportionately on the White Mesa Ute community.	lands would require environmental documentation compliance with NEPA.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	57	The DEIS is deficient when it fails to take into account the legacy of harm and cumulative impacts caused by past uranium activities near Navajo communities in its assessment of environmental injustice impacts. DEIS at 4-239. It concludes that there are other non-environmental justice communities within the study area that could be exposed to the same health risks; therefore, these effects are not expected to be disproportionate to tribal environmental justice communities. Non-tribal communities, such as St. George, Orderville, and Hildale cited in the DEIS, and non-environmental justice communities have been unaffected by several decades of uranium mining that occurred on Navajo lands, beginning in the 1950s. Unlike Navajo communities, they are not currently suffering from the preexisting cumulative impacts of past uranium activities. Navajo people will therefore be disproportionately affected by the cumulative impacts of new uranium mining. NEPA requires the consideration of "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency undertakes such other activities." 40 CFR 1508.7. The DEIS should acknowledge that implementing Alternative A will cause significant impacts to Navajo people because it will result in *disproportionately high and adverse environmental health impacts to an identified minority or low-income population that appreciably exceed those to the general population around the project area.* DEIS at 4-232.	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology; the revised analysis in the FEIS no longer includes a comparison to non environmental justice communities. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in “Stakeholder Values.” The history of adverse health outcomes and increased cancers in the Navajo miners are beyond the scope of the EIS, as discussed in Stakeholder Values (see Section 3.15 of the DEIS). The revised environmental justice analysis in the FEIS thoroughly addresses cumulative impacts to the Navajo Tribe, and other low-income or minority communities in or near the area proposed for withdrawal, as required by law and the Executive Order.
Ted Jensen	225282	12	It seems wrong that Fredonia did not qualify for Environmental Justice status (pg 3-248). The town is in a state of near total welfare. Those with jobs have to travel to Las Vegas, Page, and other areas.	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology. However, Fredonia does not meet the criteria for an Environmental Justice Community. A statement of clarity has been added to Section 3.16 in the FEIS.
		15	The comparison to the Blanding uranium processing to mining impacts on the Arizona Strip is very misleading (see page 3-242). They are very different and the mining process has much less radiation impacts if any as compared to downwinder impacts already in the area.	The public health and safety discussion in the DEIS (see Section 3.15) discusses the differences between mining and milling.
Quaterra Alaska Inc.	225288	2	Some of the indicators of an investigator letting his anti-industry bias influence his findings are: Introducing irrelevant issues. An example of this is on page 3-242 where the investigator infers that miners would be exposed to toxic levels of depleted uranium. Depleted uranium is never encountered in uranium mining and miners do not ingest enough natural	The EIS does mention depleted uranium related to health effects. This is not to imply that miners would be exposed to depleted uranium but rather since more is known about health effects from exposure to depleted uranium it is used here to help fill in gaps of knowledge

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			uranium to be toxic. Depleted uranium is in a chemical form different from natural uranium. Another example is describing in detail a plant or animal which does not exist in the withdrawal area. Someone merely skimming the document might miss that the plant or animal does not exist in the withdrawal area; is this intentional?	related to expected adverse health outcomes in miners from exposure to natural uranium. As discussed in the FEIS, natural uranium is more radioactive and may cause more health effects that DU.
Quaterra Alaska Inc.	225288	3	Some of the indicators of an investigator letting his anti-industry bias influence his findings are: Inferring that something out of the past is representative of the situation today. An example of this is inferring that modern uranium mining is the same as it was 50+ years ago in the infancy of uranium mining when it was a U.S. government project. Present-day standards for ventilation, dust control, radiation exposure monitoring, reclamation, mine safety, and water control did not exist in the early uranium mines. Many early miners smoked while working, which increases the chances of lung cancer 100-fold, while at present-day mines mere possession of smoking materials is grounds for immediate dismissal.	The EIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable Development Scenarios, Section B.3, Regulatory Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
Quaterra Alaska Inc.	225288	4	Some of the indicators of an investigator letting his anti-industry bias influence his findings are: Contriving impossible or extremely unlikely situations and presenting them as the norm. An example of this is the investigator describing a situation where animals graze on vegetation which contains wind-borne dust of uranium minerals and are contaminated, then people eat the animals and are also contaminated. This is just an example of impossible or extremely unlikely events described in the EIS.	The DEIS discusses this possibility based on the wildlife analysis (see Sections 3.7 and 4.7), and documented human health risks (see Sections 3.15 and 4.15).
Quaterra Alaska Inc.	225288	8	Traffic resulting from ore hauling should be directly compared to overall traffic on various highways	Because the actual locations of possible mines is unknown, changes in traffic on any particular roadway are also unknown. An estimate of traffic effects based on possible mine locations is discussed in EIS Section 4.16. The Transportation Conflicts section of the FEIS has been updated (see Sections 3.16 and 4.16) to provide further context for changes in traffic.
Maren Mahoney	226214	4	The EIS conclusion that there will be no disproportionate health or environmental impacts to the communities that fall under the environmental justice criteria is inadequately supported.The EIS Chapt 4 p 239 provides that there "are numerous other non–environmental justice communities within the study area that could be exposed to the same health risks." The EIS fails to identify these communities and to adequately explore the potential disproportionate health impacts to the EJ-identified communities. For example, the EIS fails to analyze or explain how potential impacts to the Havasupai could possibly be the same as to other communities.	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology; the revised analysis in the FEIS no longer includes a comparison to non environmental justice communities. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in “Stakeholder Values.” The history of adverse health outcomes and increased cancers in the Navajo miners are beyond the scope of the EIS, as discussed in Stakeholder Values (see Section 3.15 of the DEIS). The revised environmental justice analysis in the FEIS thoroughly addresses cumulative impacts to the Havasupai, and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				other low-income or minority communities in or near the area proposed for withdrawal, as required by law and the Executive Order.
Kate Johnston	226267	3	The number of employees per mine is vastly understated, leading to the DEIS underestimate the impacts of sewage, transportation and housing infrastructure required by a 200-unit, rather than 75-unit workforce.	The DEIS analysis is based on estimates provided by the mining industry (see Sections 3.16 and 4.16). Additionally, the 75 employees are considered a direct impact, while indirect employment (also discussed in the DEIS), would include jobs used to support mining, such as sewage, transportation, etc. However, please note the employment analysis in the FEIS has been revised based on the revised IMPLAN analysis (see Sections 3.17 and 4.17).
Central Arizona Project	242648	1	The DEIS for the Northern Arizona Proposed Withdrawal Project indicates that all of the alternatives evaluated would result in a negligible increase in uranium concentrations in the Colorado River over historical background levels. It should be noted, however, that the effects of increased mining within the subject area may affect consumer confidence over the safety and reliability of the Colorado River for its use as a municipal drinking water supply, irrespective of any definitive public health impacts. Considering the tragic aftermath of the recent earthquake and tsunami in Japan, the public has a heightened concern over the potential for even minute amounts of radiation in water supplies. As such, it is critical that a comprehensive water quality monitoring program be in place to inform stakeholders and ensure long-term protection of the Colorado River from threats of uranium and other regulated constituents impacted by mining operations for all alternatives being investigated.	The “Stakeholder Values” section of the FEIS (see Sections 3.16 and 4.16) has been updated to reflect perceptions about water quality safety.
VANE Minerals	242650	9	The above comment also pertains to the Impacts on Social Conditions presented on page ES-15. The DEIS states, *Alternative A could result in minor long-term impacts* ...We disagree with this conclusion because Alternative A "will" result in long-term impacts and it can be argued that those impacts "Would" be moderate and "could" be major. However, more important is that the DEIS ignores the impacts on Social Conditions should Alternatives B, C, or D be implemented. The implementation of Alternative B will result in immediate, as well as eventual, longterm impacts on employees of the industry through job loss. Alternatives B, C, and D, will also result in long-term impact on those directly benefiting from mining. The immediate impacts will be from employees losing jobs that were being retained in anticipation of the area not being withdrawn. Eventual impacts will be the loss of jobs when the existing mines are mines out. One cannot put a price on the permanent impacts on a family due to the loss of a job, especially one due to a political action.	The DEIS analyzes impacts to stakeholder values in terms of job loss (see "Mineral Activity Support" in Section 4.15) for all alternatives. Additionally, impacts under Alternative A are considered minor because these would be a continuance of existing conditions. The analysis explains the change will not be major. Finally, the analysis does not use “will” when discussing impacts as no alternative has been selected.
Janet Remington	244004	1	If uranium mining is allowed in or near the Grand Canyon, which carcinogens will be released into the air and water?	As discussed in Section 4.16 of the FEIS, with appropriate mining practices, no carcinogens should

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				be released during mining or if they are, they should be at levels below which no adverse health effects are seen. As to compounds that would be encountered during the mining, the International Agency for Research on Cancer (IARC) has listed radon as a human carcinogen. It has not classified imbedded depleted uranium (DU) and it has not classified uranium specifically as a carcinogen. Uranium does emit alpha particles and IARC classifies alpha particles as a known human carcinogen."
U.S. Geological Survey	242871	4	Given the complexity of radiation toxicity, we think that it would be unwise to speculate on risks to human health. Questions like these should be deferred to EPA or state health agencies.	The issue of radiation toxicity was determined to be an issue for analysis in the EIS due to concerns by the public and the project interdisciplinary team. The EIS analyzes impacts to public health and safety based on the best available science. Any future site specific analyses would also be required to analyze impacts to human health.
Jaina Moan	54353	3	The Draft Environmental Impact Statement on the proposed withdrawal understates the negative impacts of not withdrawing this land (Alternatives A, C, and D). The negative impacts of mineral exploration and mining are understated because of 1) factors that are not considered in the DEIS, and 2) factors whose negative impacts are understated in the DEIS. The most significant factors not considered in the DEIS are the economic, safety, and environmental impacts of the transport of uranium ore from the 30 mines proposed if no lands are withdrawn (DEIS Alternative A). SEDI's analysis indicates that the DEIS calculation of 300,165 round trips from mines in the north, east, and south parcels to the White Mesa Mill would require ore hauling trucks to travel a total of 184,435,893 miles over life of the mines. According to US Department of Transportation accident data, these trips would be expected to result in 367 accidents, causing 151 injuries and 4 deaths. (See the attached spreadsheet for this analysis of US Department of Transportation data) *** Attached Table "SEDI Comments- Transportation Impact of Grand Canyon Uranium Mining-Alternative A**	The Transportation Conflicts discussion in Section 3.15 and 4.15 of the FEIS has been updated based on new information provided by the public and using a more refined methodology based on risk frequency calculations for hazardous material transportation (USDOT 2007).
Cynthia Pardo	104133	1	The socioeconomic conditions do not appear to assess fully the impact on communities around the proposed withdrawal, in particular the tribal and low income and minority populations. Please address the environmental justice impact and acknowledge that certain communities will be disproportionately affected by uranium mining and by all alternatives. The health and livelihoods of the communities, including wildlife, depend on a thorough assessment of environmental justice impact based on a thorough, true, broad, definition of environmental justice.	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology; the revised analysis in the FEIS no longer includes a comparison to non environmental justice communities. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in "Stakeholder Values." The history of adverse health outcomes and increased cancers in the Navajo miners are beyond the scope of the EIS, as discussed in Stakeholder

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Values (see Section 3.15 of the DEIS). The revised environmental justice analysis in the FEIS thoroughly addresses cumulative impacts to the tribes in the study area, and other low-income or minority communities in or near the area proposed for withdrawal, as required by law and the Executive Order.
Cynthia Pardo	104125	2	Contamination by uranium and other trace element should be analyzed in residential areas, including the tribal lands around and in the Grand Canyon. The legacy and contamination must be assessed on quantitative assessments and not estimates or just historical events.	The DEIS includes a discussion of how past uranium mining has impacted tribal lands in terms of stakeholder values (see Sections 3.15 and 4.15). Contamination by uranium or other trace elements from uranium mining operations within the proposed withdrawal area would not be expected to occur in residential areas, including tribal lands, because of the relative scarcity of such areas within the Withdrawal Area and the limited aerial dispersion potential for trace elements from mine sites (typically a few hundred feet). Additionally, any future mining operations would undergo site specific NEPA analysis for air and water quality, as well as socioeconomics.
Cynthia Pardo	104125	3	These sections on social and economic, and environmental justice do seem to reflect the true costs of uranium contamination and legacy effects- Please include data from tribal agencies and tribal consultations for these sections.	The DEIS includes a discussion of how past uranium mining has impacted tribal lands in terms of stakeholder values (see Sections 3.15 and 4.15).
Cynthia Pardo	104125	4	The impact on poor populations does not seem to be developed enough and is lacking assessment in all Alternatives.	The Environmental Justice discussion in the FEIS has been updated based on new information provided by the public and using a more refined methodology; the revised analysis in the FEIS no longer includes a comparison to non environmental justice communities. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in “Stakeholder Values.” The history of adverse health outcomes and increased cancers in the Navajo miners are beyond the scope of the EIS, as discussed in Stakeholder Values (see Section 3.15 of the DEIS). The revised environmental justice analysis in the FEIS thoroughly addresses cumulative impacts to the tribes in the study area, and other low-income or minority communities in or near the area proposed for withdrawal, as required by law and the Executive Order.
Albert Hale	213921	3	The DEIS should acknowledge that implementing Alternative A will cause significant impacts to Navajo people because it will result in " Disproportionately high and adverse environmental health impacts to an identified minority or low-income population that appreciably exceed those	The Environmental Justice discussions in the FEIS in Sections 3.16 and 4.16 have been updated based on new information provided by the public and using a more refined methodology. The legacy of mining on

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			to the general population around the project area" (DEIS, p. 4-232).	the Navajo Nation is discussed in Section 3.15 of the DEIS in "Stakeholder Values." The revised environmental justice analysis thoroughly addresses cumulative impacts to the Navajo Tribe and other low-income or minority communities in or near the area proposed for withdrawal as required by law and the Executive Order.
Albert Hale	213921	4	The DEIS is deficent when it fails to take into account the legacy of harm and cumulative impacts caused by past uranium activities near Navajo communities in its assessment of environmental injustice impacts (DEIS, p. 4-239). It concludes that *"there are other non-environment justice communities within the study area that could be exposed to the same healh risks; therefor, these effects are not expected to be disproportionate. To tribal environmental justice communities.*" Non-tribal communities, such as St. George, Ordervill, and Hildale cited in th DEIS, and non-environmental justice communities have been unaffected by serverall decades of uranium mining that occurred on Navajo lands, beginning in the 1950s. Unlike Navajo communities, thar are not currently suffering from the pre-existing cumulative impacts of past uranium activiies. Navajo people will therefore be disproportionally affected by the cumulative impacts of new uranium mining. The National Environmental Policy Act requires the consideration of "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency undertakes such other activities" [40 CFR 1508.7]	The Environmental Justice discussions in the FEIS in Sections 3.16 and 4.16 have been updated based on new information provided by the public and using a more refined methodology. The legacy of mining on the Navajo Nation is discussed in Section 3.15 of the DEIS in "Stakeholder Values." The revised environmental justice analysis thoroughly addresses cumulative impacts to the Navajo Tribe and other low-income or minority communities in or near the area proposed for withdrawal as required by law and the Executive Order.
Soils				
American Clean Energy Resources Trust (ACERT)	225256	34	3.5.4 CURRENT RESOURCE CONDITIONS: EFFECTS FROM HISTORIC (1980S) MINING: PIGEON MINE Page 3-103 Statement re: Source of Anomalous Uranium and Arsenic Comment: The EIS attributes anomalous U and As at the reclaimed Pigeon Mine as being left over from mining. Anomalous U and As values in the vicinity of the reclaimed Pigeon mine could be from material left on site after reclamation. However experience has shown that any rock high in iron oxide at this stratigraphic horizon always contains very anomalous As, sometimes as high as 3600 ppm, even in areas away from breccia pipes. Such rocks also occasionally contain anomalous uranium. The anomalous U and As could be left over from mining but it could also be naturally occurring in the outcrop.	The two anomalously high sample results (68 and 79.1 ppm for uranium and 377 and 407 ppm for arsenic) were reported in Otton and others (2010) as likely representing "soil contaminated by partly exposed waste material." This statement was based on field observations of deposits present on site. Sampling of surface soils in the perimeter of the mineralized pipe area prior to mining indicated a uranium concentration of the soils ranging from 2.2 to 5.6 ppm (Hopkins et al. 1984b). A much more extensive soil sampling program of breccia pipes and collapse features in the region is provided in Van Gosen and Wenrich (1991). Out of 43 breccia pipes and collapse features studied, the maximum reported uranium concentration was 24.9 ppm and the maximum reported arsenic concentration was 96.8 ppm. Thus, the Pigeon sample concentrations referenced above are anomalously high, and the source of the elevated trace elements is

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				not likely to be naturally occurring parent material containing elevated concentrations of uranium and/or arsenic.
American Clean Energy Resources Trust (ACERT)	225256	35	3.5.4 CURRENT RESOURCE CONDITIONS: EFFECTS FROM HISTORIC MINING: HACK CANYON MINE COMPLEX Pages 3-105,3-106 Statement *re: Hack Canyon Mine* Comment: The original Hack Canyon Mine was for copper, not uranium (Pat Hillard's personal communication with Blondie Jensen and Jense McCormick, operators of the Hack Canyon mine, both deceased). Supplies were hauled in and the copper ore hauled out by pack horse. Parts of the trail can still be seen along the north side of upper Hack Canyon. Later a road was constructed down to the bottom of the canyon. Uranium was discovered by Western Nuclear by drilling on the same pipe as the Hack Canyon copper mine. Trace amounts of uranium had been encountered in the early copper mining operation.	This detail regarding the origin of Hack Canyon mine has been added to the FEIS in Section 3.5.4 under the sub-heading "Effects From Historic (1980s) Mining" and in the bullet "Hack Canyon Mine Complex."
American Clean Energy Resources Trust (ACERT)	225256	36	3.5.4 CURRENT RESOURCE CONDITIONS: EFFECTS OF HISTORIC MINING: HACK CANYON MINE COMPLEX Pages 106 thru 3-108 Statements *re: Variability in soil and bedrock chemistry*. Comment: Some pipes have a plug of bimodal sandstone in their throat which is equivalent to uppermost Kaibab beds. This sandstone was deposited before Moenkopi deposition began, and is younger than the pipe breccia. There may be cases where this sandstone is older than the pipe breccia, however in these cases it is usually not recognizable because of downdropping and mixing with clasts of other rock types. The sandstone plug usually contains local areas of iron oxide with anomalous arsenic and other metals. There is occasionally slightly anomalous uranium in this sandstone, however it is difficult to detect the anomaly in the field instrumentally because of significant variability in local background radioactivity. In areas of Kaibab Formation outcrop in northern Arizona soil-covered areas have significantly higher background radioactivity than outcrop areas. Within a 200 foot distance the background radioactivity can change by a factor of 1.7, depending on the amount of soil. It has also been observed that Moenkopi outcrop is approximately 1.75 times more radioactive than typical Kaibab outcrop. Therefore some of the anomalous uranium and arsenic are due to natural causes, and some could have been introduced by mining. Without pre-mining data it is difficult to determine in many cases. The relevant point here is that some variations in background radioactivity are natural and are due to variations in the amount of soil or rock type.	The field MicroR survey results reported in Otton et al. (2010) are the only published radiometric survey results for background conditions in the study area. In addition to the survey of the Jumpup Canyon area (page 63), the Otton el al. (2010) study included surveys of the Kanab South drill site (page 112) and areas adjacent to the Hermit mine (page 113). The information in Otton et al. (2010) regarding background radioactivity levels in the area has been added to the FEIS in Section 3.5.4 under the sub-heading "Effects From Historic (1980s) Mining" and in the bullet for "MicroR Meter Surveys."
American Clean Energy Resources Trust (ACERT)	225256	87	Pages 4-101- 4-108, 4-108 to 4-109 Comment: Mining of locatable minerals causes soil disturbance resulting in soil erosion and contamination. However, damage to all three parcels scheduled to be withdrawn is also caused by many other activities: fuels management, noxious weed control, wildfires, droughts, cattle grazing, recreational	The purpose of this EIS is to assess the impacts of the Proposed Action and Alternatives. Comparisons of impacts with activities other than reasonably foreseeable uranium mining are not relevant to the purpose of this EIS, but were used only as a method of

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			activities (developing roads, trails, campgrounds), installation of water and power lines, development of private lands, drilling for oil, gas, or water, fluid mineral leasing, mining on leased or sold lands (sand and gravel, copper, stone quarrying) and past uranium mining activities. This is applicable to all Alternatives, including B. The activities unrelated to mining of uranium listed above cause damage to the soil greater by an order of magnitude than any uranium mining would cause. Many of these other activities are not regulated or controlled as well as uranium mining. So impact to soil resources because of mining should not even be an issue. However, the summary presented in Table 2.8-1 does not reflect this and gives the reader the impression that mining can be the cause of considerable damage. This is very misleading.	assessing the incremental effect of foreseeable uranium mining to the overall cumulative impact and not as a means of determining significance of impact. The cumulative impacts of mining and other activities have been estimated in EIS Section 4.5.3. A reference to this section has been added to Table 2.8-1 in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	88	Pages 4-106, 4-107, end of third paragraph. Statement: *Although the individual impact from these activities may be relatively small, the cumulative impact would be expected to be large. Anticipated population growth in the region, primarily in southern Utah, might accelerate disturbance by way of increased development on private property (primarily in the North Parcel) and increased development and use of recreation areas (such as trails and campgrounds).* Comment: The EIS says that development on private property within the north withdrawal area might contribute considerably to cumulative impacts. There is little private ground inside the north withdrawal area, and what is there does not have high potential for uranium, and is not well suited for anything other than cattle grazing, therefore there would be minimal effects from development on private land.	Although it is true that there is little private land within the North Parcel, the text refers to potential impacts from development in general on private property within and adjacent to the withdrawal area. This is clarified in FEIS Section 4.5.3 (Subsection Cumulative Impacts).
Uranium Watch	225262	36	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The DEIS discussion of Impacts Common to All Alternatives (Section 4.2.4, page 4-16) manages to totally ignore the radioactive and hazardous constituents of any fugitive dust from the mining operation. The EIS must identify all hazardous radioactive and non-radioactive constituents of fugitive dust from the uranium mining operations and assess their impact on the environment. This would include an evaluation of potential exposure pathways and impacts to the public, workers, ground and surface water, soils, vegetation, and native and domestic animals over the short and long term.	The justification for analyzing impacts from uranium and arsenic dispersion in fugitive dust is provided in EIS Section 4.5.1, Subsection Assumptions for Impact Analysis. Impact to soils from fugitive dust are discussed in the EIS in Section 3.5.4 (Subsection Effects From Historic (1980s) Mining) for effects at previously mined sites and in Section 4.5.3 (Subsection Soil Contamination) for projected impacts related to future mining. In addition, the EIS also discusses fugitive dust in Section 4.6, 4.7 and 4.8. When a Mine Plan of Operations is proposed for a new mine, site specific NEPA analysis would be conducted to address site-specific conditions before the new mine could be authorized.
Uranium Watch	225262	62	The discussion of Soil Contamination (Section 4.5.1, page 4-96) should have included the potential for soil contamination from the release and dispersion of radon and radon progeny from the mine vents, mine portal, evaporation and containment ponds, water treatment facility, ore, waste rock, equipment, discharge of mine water, leaks, spills, drilling mud	There is relatively little potential for radon that might be released from the cited sources to contaminate soils. Most soils naturally release radon into the atmosphere, and it is unlikely that radon emissions from mine-related sources would result in accumulation of radon

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			disposal, and ore handling operations.	in soils because it is a gas, not a particulate.
Uranium Watch	225262	63	The discussion of Assumptions for Impact Analysis (Section 4.5.1, page 4-99) should have included the impacts of mine vent installation. Mine vents can be installed at various locations, often some distance from the mine portal. Surface impacts include access roads, vent installation area, removal of topsoil prior to the construction of the shaft and installation of the vent, and disposal of waste rock from the vent shaft construction. Vents must be accessible during their lifetime. The more mines, the more vents, which are used to provide fresh air to the mines and exhaust radon.	Mine vents are part of the mine facilities and are included in the estimated surface disturbance per mine site, as discussed in Appendix B. Review of Plans of Operations for the Pinenut, Hermit, and Arizona 1 mines indicates that only one vent is typically installed and it is usually located within the mine site perimeter or disturbed area (Energy Fuels Nuclear, Inc. 1986, 1987, 1988b). In unusual cases where the mine vents are not located within the mine perimeter, the vent represents a small area of surface disturbance (< 0.1 acre to 1 acre) (Energy Fuels Nuclear, Inc. 1982; JBR Environmental Consultants 2010). The positioning of the vent depends on the relative location of the ore body to the main shaft. Activities listed in the comment relate to surface disturbance except disposal of waste rock, which would be governed by an approved Plan of Operations and would be expected to be consistent with disposal of waste rock generated during installation of the main shaft and mine workings. When a Mine Plan of Operations is proposed for a new mine, site specific NEPA analysis would be conducted to address site-specific conditions before the new mine could be authorized. Energy Fuels Nuclear, Inc. 1982. *Plan of Operations, Kanab North Project.* June.
Uranium Watch	225262	64	The discussion of Soil Contamination (Section 4.5.3, page 104) should include an evaluation of the potential of soil contamination from the release and dispersion of radon and radon progeny from the mine vents, mine portal, evaporation and containment ponds, water treatment facility, ore, waste rock, equipment, discharge of mine water, leaks, spills, drilling mud disposal, and ore handling operations.	Same response as comment 225262-62 (Uranium Watch).
Uranium Watch	225262	65 & 66	The discussion of Soil Contamination (Section 4.5.3, page 104) only discusses the amount of uranium and arsenic found at historic uranium mine sites. There is no discussion of the amount of radium-226 in the soil at these sites, nor is there a discussion of a cleanup standard for radium at historic, current, or foreseeable uranium mine sites. The cleanup standard for uranium mill sites after closure is 5 pico Curies per gram (pCi/g) of radium-226 (above background) in the first 15 cm below ground and 15 pCi/g of radium-226 (above background) below 15 cm, averaged over 100 square meters. 4 The EIS must compare the standard for the cleanup of uranium on the surface of uranium mine sites in Arizona with the EPA standard for the cleanup of the contaminated soils at uranium mills.	The standard cited by the commenter applies only to cleanup of specific mill sites under the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (40 CFR 192). Because radium is present in only very small amounts in uranium ore (http://periodic.lanl.gov/88.shtml), and all uranium ore will be processed off site, radium-226 is unlikely to be present in significant quantities at the mine sites. Comparison of cleanup standards for radium and uranium at concentrating mills vs. standards at mine sites where only waste materials may be present at

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			The discussion of Soil Contamination (Section 4.5.3, page 104) refers to a cleanup standard for uranium. That ADEQ standard is given in parts per million. The EIS should also give that standard in pCi/g. The standard of 200 ppm of uranium is equivalent to 136.65 pCi/g, which is far higher than the standard for the cleanup of radium at uranium mill sites.	closure is not appropriate to this NEPA document. In addition, no data are available to assess radium-226 in terms of area background concentrations and concentrations at former uranium mine sites in Northern Arizona. Thus, it is neither essential nor feasible to incorporate Radium-226 into the impact analysis in order to form a basis for Agency decision. It is not appropriate to reference a standard for uranium in terms of activity (i.e., picocuries per gram) because uranium standards are based on its chemical toxicity, which represents a much greater risk than its relatively weak radioactive properties (http://www.epa.gov/rpdweb00/radionuclides/uranium.html). Radium-226 is strongly radioactive and emits gamma radiation, which represents a direct exposure risk. Thus, the rate of decay for uranium does not represent the same risk as an equal rate of decay for radium.
Uranium Watch	225262	68	The EIS must evaluate the impacts from the long-term presence of mine waste and contaminated soils associated with historic, current, and foreseeable uranium mining operations in the withdrawal area. The EIS must discuss their plans for long-term care and inspection of the mine sites.	The soils impact analysis presented in Section 4.5 of the EIS does indicate that contamination has the potential to be present long term and could disperse off site where it will likely be diluted with native sediments (see EIS Section 3.5.4 (Subsection Effects From Historic (1980s) Mining) and in Section 4.5.3 (Subsection Soil Contamination). Plans for long-term closure are provided in the Plan of Operations approved for each mine. Methods for reclamation and monitoring of existing and previous mines typically employed are described in EIS Section 4.5.2. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Uranium Watch	225262	69	The BLM or USFS must explain why the Kanab North site has not been reclaimed (Section 4.5.3, page 104). No additional mining should be	The Kanab North Mine was approved in the late 1980s and mining was conducted there until the collapse of

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			approved by the BLM or USFS until all non-operating uranium mine sites in the withdrawal area have been fully reclaimed.	the Soviet Union caused uranium prices to plummet. The regulations under which the mine was approved allowed for the mine to be managed under Interim Management until the company could economically reopen the mine. There was no time limit for operating under Interim Management in the regulations when the Kanab North Mine was approved. The Kanab North mine remained under interim management for over 20 years because the mine owner believed it might be feasible to re-start active mining operations. Recently, the mine owner has reconsidered the feasibility of reopening the Kanab North and they are preparing to close the mine and reclaim the site. The mine owner is working with BLM to develop a timeline for implementation of the reclamation plan, and is coordinating with ADEQ to determine if additional requirements must be met for closure.
Uranium Watch	225262	71	The long-term impacts to the soils in the area from additional uranium mine operations under alternatives A, C. and D will be greater than anticipated because there will be no long-term surveillance and monitoring of the sites. There will be no signs warning people that the sites are contaminated, and uranium, radium, arsenic and other radioactive and non-radioactive contaminants will continue to disperse into the environment. The long-term impacts to the surface and other aspects of the environment under alternatives A, C. and D are unacceptable.	Please see response for 225262-68 (Uranium Watch)
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	22	Relative to Otton et al. (2010), the DEIS creates a new category for characterizing naturally occurring uranium and arsenic in undisturbed soil and sediment called "study area maximum." Study area maximum is additional to "regional average values" defined by Otton et al (2010). DEIS at 3-102. If the purpose of adding an additional category is to better describe past and potential future mining impacts relative to undisturbed soil conditions, then it is curious why the DEIS fails to also add a "study area minimum" category, or a "minimum" value for undisturbed soil samples collected at breccia pipes. Adding only maximum values to average values described by Otton et al. (2010) has the effect of downplaying past and potential mining impacts to soil uranium concentrations and accordingly skewing effects analyses. An objective characterization of conditions and effects would either just rely on an average value, as did Otton et al. (2010), or include minimum, average and maximum values.	The discussion of the maximum concentration for naturally occurring uranium provides context for the potential site-specific concentrations that could be present at a given site and does not replace the average concentration definition of background for the region. The minimum naturally occurring concentration does not provide a particularly meaningful context for impacts when considering individual sample results because a concentration in a specific location that is at or above the minimum and below the maximum for naturally occurring concentrations may not represent an impact, whereas a concentration above the maximum clearly represents a potential impact. The minimum naturally occurring uranium and arsenic concentrations are discussed in the text. However, to provide a clear and complete description of the affected environment, the range of reported concentrations has been added to Table 3.5-2 in the FEIS. Regardless of the entries listed in Table 3.4-2, it

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				is clear from review of Section 3.5.4 (Subsection Effects From Historic (1980s) Mining) that concentrations at and/or adjacent to former mine sites are at least several ppm above background concentrations described for the region and at unmined uranium-bearing breccia pipes (when comparing averages to averages and maximums to maximums). Thus, providing a characterization of naturally occurring concentrations of uranium and arsenic that includes a maximum potential value does not result in a "skewed" impact analysis (as provided in Chapter 4). However, excluding mention of the maximum concentrations would suggest any value in excess of the average represents an impact, which is not necessarily true.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	23	The study area maximum value is derived from a single sample collected by Hopkins et al. (1984) at the Pigeon breccia pipe, the location of the Pigeon uranium mine. The Pigeon pipe is located in a drainage; the sample relied on in the DEIS, which measures 5.6 ppm uranium, is one of 40 samples collected from stream alluvium. All other 39 samples measured 2.6 ppm or less; the DEIS relies on a single high outlier sample to establish "study area maximum" soil uranium concentration for the entire analysis of effects. But it is not even clear that the Pigeon pipe samples collected by Hopkins et al. (1984) were collected prior to exploratory drilling or therefore reflect undisturbed natural background soil conditions. Hopkins et al. report samples were collected in 1982. Otton et al. (1984) state: *The pipe was discovered in 1980. The site was prepared and developed from 1982 to 1984, and mining began in December 1984.* Otton et al. (1984) at 63. In mining parlance, "discovered" typically marks the confirmation of a viable ore body after exploratory drilling. The LR2000 database shows that the first application received for the Pigeon pipe, serialized as AZA025967, was received on March 16, 1981. Both dates, 1980 and 1981, precede sampling in 1982 by Hopkins et al. (1984); this suggests that the Pigeon pipe in 1982 had already been subject to exploratory drilling and was not “"undisturbed soil." In fact, Hopkins et al. (1984) state that rocks had been altered at the time of sampling, indicating that some activity had occurred at sample sites, and that those altered rocks were included in samples: *We collected rock samples from outcrops or exposures in the vicinity of the plotted site location. Most samples were collected from unaltered rock. Rock samples provide information on elements in rocks that have not been affected by alteration or mineralization. In addition, some altered rocks were collected.* Hopkins et al. (1984) at 3. Unless BLM can demonstrate that Hopkins et al.'s (1984) Pigeon pipe sample was not measuring drilling residue, the DEIS cannot rely on that value to characterize a "study area maximum" of "naturally	The 5.6 ppm value cited in the DEIS is not an unrealistic representation for the potential maximum concentration of naturally occurring uranium in soils in the region. For example, concentrations of uranium in excess of 5.6 ppm were detected in many soil samples collected at several different collapse features in the study area (Van Gosen and Wenrich 1991) (features 474, 249, 491, 1102, 1108, 1152, and 1173). The maximum reported uranium concentration in soils sampled at and around these features was 24.9 ppm. These features were not drilled at the time of sampling and, thus were not disturbed. Otton and others (2010) (page 56) conclude that there is little difference between concentrations of trace elements, particularly uranium, in soils within the surface expression of mineralized breccia pipes and those adjacent to pipes. Thus, soil conditions at collapse features of unknown mineral potential are appropriate to compare to conditions at mineralized pipes because geologic conditions are similar. An additional description of the Pigeon pipe samples collected in 1982 was provided in Billingsley et al. (1983). USGS staff collected the samples in fresh surface cuts in the perimeter of the pipe before the mineralized area had been exposed. Results from those samples were said to indicate weakly anomalous concentrations of several elements, but not uranium. The surface area typically disturbed by drilling operations is comparatively small relative to the pipe surface expression and soil samples could only really be contaminated if collected at a former

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			occurring uranium in undisturbed soil."	mud pit or cuttings pile, which would have been avoided by USGS scientists. There is no reason to believe that one of the three Pigeon samples was contaminated with drill cuttings; clearly the USGS did not suspect sample contamination. The "alteration" that Hopkins et al. (1984b) refer to is alteration from natural geochemical mineralization processes; the objective of the Hopkins et al (1984) study was to determine the extent and degree of such mineralization in the Snake Gulch area.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	24	After relying on a single, high outlier value to characterize natural background uranium concentrations in soil, the DEIS then excludes high outlier values in its characterization of post-mining "reclaimed" soil conditions at the Pigeon mine. In its discussion of the Pigeon mine, the DEIS states: *The average concentration of 15 soil samples obtained in the vicinity of the operations area was about 11.9 ppm for uranium and about 29 ppm for arsenic (excluding one anomalously high sample result with a uranium concentration of 206 ppm, and an arsenic concentration of 455 ppm). Several isolated deposits of mine waste remaining on-site, primarily in the operations area, were sampled; uranium concentrations as high as 1,230 ppm and arsenic concentrations as high as 1,980 ppm were detected in these samples.* DEIS at 3-103. In addition to excluding the 206 ppm uranium sample, the DEIS then also excludes the 1230 ppm uranium sample from reporting of "outliers" in Table 3.5.3.; it instead reports as high outlier values of 68 and 79.1 ppm. The effect of excluding both values, 206 and 1230 ppm, is to downplay and misrepresent the impact of past mining.	Refer to response for 225279-22 and -23 (CBD) regarding maximum concentrations for naturally occurring uranium and arsenic. The table entry for the Pigeon mine in Table 3.5.3 only provides a summary of the reclaimed pipe surface, referred to as the "Mine Site" in Otton et al. (2010). This was because Otton et al. (2010) do not provide summary statistics for the Pigeon Mine “operations area;” rather it only discusses results along two traverses made across the site. Thus, to the extent that this section of the EIS is a summary of the results of Otton Et al. (2010), results for the Pigeon Mine operations area do not readily lend themselves to inclusion into the summary table (i.e., Table 3.5-3). Table 3.5-3 has been updated in the FEIS to note this distinction. The sample results for the operations area are not excluded simply because they were not listed in the summary table; it is sufficient to discuss the data in the body of the text. The concentration value of 1,230 ppm for uranium is from mine waste material, not soil and so should not be included in the summary table in any event.
The NAU Project, LLC	242913	78	Degradation of soil productivity is of low probability, and areas within this erosion hazard class generally stabilize under natural conditions. Areas rated moderate exhibit PSL rates that exceed TSL rates, and loss of soil productivity is probable; reasonable and economically feasible mitigation measures are required to prevent significant losses in productivity. Severe hazard ratings are assigned to areas where PSL rates exceed TSL rates and where loss of productivity is inevitable. Areas with severe erosion hazards require significant mitigation measures to be applied to prevent irreversible loss in soil productivity, and there is a high probability of some productivity loss before mitigation can be applied. What might these mitigating measures be? Are they well established ones or new ones? What mitigating measure could be developed such that mitigating measures would be applied before productivity loss occurred?	Because the Proposed Action and Alternatives being analyzed in this EIS are various configurations of withdrawal from the Mining Law of 1872, mitigations to withdrawal are not appropriate. Mitigation measures will be incorporated into any future site-specific NEPA analyses conducted to approve specific Mine Plans of Operations.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
		86	Impacts to soil chemical quality page 4-105 Data collected by the USGS in 2009 (Otton et al. 2010) at the reclaimed Pigeon and Hermit mines support this conclusion; at the Pigeon Mine, only localized areas of soil were detected containing higher levels of trace elements than elsewhere on-site. These higher levels of mine-related constituents were likely related to the presence of mine-waste materials remaining on-site, possibly uncovered by erosion. These residual impacts are an example of reclamation efforts that were not completely successful; such impacts are minor because of their limited extent and could be mitigated through more aggressive remedial action and monitoring after closure. So what aggressive remedial actions would you make as mitigating measures, NEPA wants to know!! The reclaimation efforts were not completely successful, so now what?	Because the Proposed Action and Alternatives being analyzed in this EIS are various configurations of withdrawal from the Mining Law of 1872, mitigations to withdrawal are not appropriate. Mitigation measures will be incorporated into any future site-specific NEPA analyses conducted to approve specific Mine Plans of Operations.
Cynthia Pardo	104125	2	Contamination by uranium and other trace element should be analyzed in residential areas, including the tribal lands around and in the Grand Canyon. The legacy and contamination must be assessed on quantitative assessments and not estimates or just historical events.	Contamination by uranium or other trace elements from uranium mining operations within the proposed withdrawal area would not be expected to occur in residential areas, including tribal lands, because of the relative scarcity of such areas within the Withdrawal Area and the limited aerial dispersion potential for trace elements from mine sites (typically a few hundred feet).
Noel Poe	106647	3	Reclamation of roads and site development. The discussion made about reclamation of surface disturbing mining activities on pages 3-245, 4-103, 4-223, etc. gloss over the difficulty of reclaiming man-made disturbances in the desert. There are statements that disturbed areas would be returned to a natural condition or such areas would be reclaimed to insure ground surface integrity is not compromised. The former is not possible and the latter is not sufficient. In addition on page 4-222, mine roads are listed as having a short term impact because they exist less than 5 years. However elsewhere in the document a statement is made that the average life of mining activities at a site is 6 years. If one looks at the figures in the USGS Legacy Report it is obvious that 10 or even 20 years of reclamation efforts have not reclaimed roads or mine sites. See Figures 5, 8, 18, and others.	The average life span of a breccia pipe uranium mine is about 5 years, not including 2 years for planning and permitting (Section B.8.1, Subsection Interim Management). Impacts to soils are discussed as potentially long-term (more than 5 years) in terms of loss of productivity (Section 4.5.3, Subsections Soil Disturbance; Increased Soil Erosion), whereas impacts related to increased soil erosion are short term (5 years or less) because reclamation efforts would be expected to reduce rates of soil loss in disturbed areas. However, the appearance of disturbance may be long-term (more than 5 years), particularly when viewed from aerial images such as those in Otton et al (2010).
Arizona State Land Department	225280	11	In Subsection B.1.3, Study Area, Tables B-1 and B-2 on page B-3 include seven or so uranium mines that were active, primarily during the 1980's. Were there any problems or issues with any of these mines that would justify the present level of concern necessary for the proposed withdrawal?	Discussion of effects on soils and stream sediments from these historic mines is given in the EIS Section 3.5.4 (Subsection Effects from Historic (1980s) Mining). This discussion draws primarily from Otton et al (2010). No definitive impacts to water resources have been determined from these (1980s-era) historic mines. However, Appendix H discusses impacts to groundwater and surface waters associated with the Orphan Lode mine.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Arizona State Land Department	225280	14	The last two sentences in Subsection B.4.5 on page B-15 are either confusing or meaningless. Are levels of uranium above background unacceptable or not since they are below levels for which ADEQ requires remediation? If the levels are acceptable, what is the point of mentioning this?	The DEIS text cited does not establish acceptability regarding levels of uranium that are in excess of background. The ADEQ remediation standard applies to non-residential areas and is used to quantify impacts in EIS Section 4.5. Levels of uranium in excess of background, but less than 200 ppm, may have specific consequences for other resources, such as wildlife. The sentences referred to in this comment have been removed in the FEIS.
Coconino County Board of Supervisors	225238	14 / 15	There is apparently no required monitoring of soils along all of the haul routes for any potential increase in radioactivity levels. The haul route from each of the three areas to Blanding involves a trip of hundreds of miles, in most cases involving trucking through established communities such as Fredonia, Kanab, Flagstaff, Page, Cameron, Tuba City and Kayenta. Monitoring of soils along the roadsides over all of the haul routes would be a daunting task, but one that should be required as part of the ongoing mining process by the companies or by the Arizona Department of Environmental Quality.	Recent hauling operations for ore produced from the Arizona 1 Mine have included some monitoring of the haul routes using dosimeters. The haul trucks are designed such that the material being transported is covered in such a way that the ore being hauled is controlled/mitigated and not allowed to escape the vehicle as a fugitive source. Ore hauling is not expected to represent a radiation risk to the public or to soils along the haul routes.
Coconino County Board of Supervisors	225238	16 / 17	Long term cumulative impacts on soil quality and radioactivity levels in soils are also typically not monitored over the long term. At the Pigeon Mine reclamation site, which from casual observation appears to have been extremely well done by the mining company, USGS tests at the site uncovered hot spots that had surfaced since the reclamation effort, demonstrating that there is certainly the possibility of the impacts of radioactivity at mine sites being carried off site in a downstream direction years after reclamation.	Please refer to the response for comment 225262-68 (Uranium Watch).
Soundscapes				
American Clean Energy Resources Trust (ACERT)	225256	102	Pages 4-190 to 4-201 Page 2-40, Table 2.8-1 Statement: Entire Section Comment: The DEIS states that the ambient noise level in non-tourist areas of the Grand Canyon National Park ranges from 18.3 to 22.8 dBA, with a log mean sound level of 20.8 dBA. Hence the ambient noise level for the DEIS is taken to be 20.8 dBA. The noise from mining activities in the areas around the boundary of the Park is attenuated by wind, and the reflection, refraction, scattering and absorption effects of barriers, vegetation, trees, hills, and other obstructions. It is admitted that *"without knowledge of the specific location of each noise source, these variables cannot be considered."* 1. Table 4.10-4 indicates that all mining equipment will attenuate to 20.8 dBA at a distance varying from 1 - 2 miles, except for semi-trailer trucks for which the distance is just below 2.5 miles. This is based on the assumption that there is no obstruction between the equipment and the receptor and there is no wind. This implies that no mine should be located closer to 2.5 miles from the boundary of the Park. In reality the height, placement of the noise sources, obstructions, spectrum	The development and operation of each individual mine would require an evaluation of its impacts on the surrounding soundscapes. This evaluation would include those parameters identified by the commenter. Mine impacts would determine the location and mitigation measures that would be required. It is beyond the scope of this EIS to evaluate the other activities and their impacts on the Park.

Table 5.6-4. Response to Comments (Continued)

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			of the noise, its duration, density and nature of vegetation surrounding the source, temperature, wind gradient, relative humidity, cloud cover, and other factors would attenuate the noise level. The probability of a mine being located closer than 2.5 miles to the Park boundary is remote. In any event each new mine would be required to have its own site-specific EIS and NEPA process. 2. The mines would operate within the hours of 7 am and 10 pm. So the disturbance would not meddle with sleeping hours. During the day there are tourist flights, construction, and a number of other noisy activities. Do these adhere to the 20.8 dBA noise level in the non-tourist parts of the Park?	
Uranium Watch	225262	77	Section 4.10 Soundscapes. Pages 4-190 to 4-201. The BLM and USFS must consider the noise from the intake and exhaust vents at the uranium mines. Some vents have fans at the top of the vent on the surface, some at the bottom in the underground workings. The fans operate up to 24 hours a day to move fresh air into the mine and to exhaust contaminated air from the mine. The noise from an operating fan on the surface is aloud roar, which can be heard over a mile away. Standing next to a vent with an operating surface fan, it sounds like one is standing next to a major freeway or on an airport tarmac. This is a major problem with the uranium mines in La Sal. There is no evidence that the federal government has done an assessment of the noise level from the vent fans or the impacts to wildlife in the vicinity of the vents.	Section 4.10.3 - *Impact Assessment Methodology and Assumptions*, Table 4.10-3. *Noise Levels (dBA) for equipment used at the Arizona 1 Mine (at 15 m)* (page 4-193), lists a calculated noise level of 78 dBA at 50 feet for the Mineshaft Vent Fan. The noise from mining activities in the areas around the boundary of the Park is attenuated by wind, and the reflection, refraction, scattering and absorption effects of barriers, vegetation, trees, hills, and other obstructions. Effects of noise from the mine operations on wildlife were assessed in Chapter 4, Section 4.7, Fish and Wildlife. Future Mine Plans of Operation will be required to undergo site specific NEPA analysis prior to their approval. The NEPA process will require a determination of direct, indirect, and cumulative impacts specific to each mine location. Without specific information regarding the location and duration of the operation of these sources, no substantive estimates of the addition of cumulative noise can be presented in this level of evaluation.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	46	**Potential Noise Impacts to Wilderness Areas Must Be Evaluated and Disclosed** The DEIS's assessment of noise impacts is limited. The DEIS identifies noise sensitive areas (NSAs) as places: *[w]here excessive noise interferes with the normal use of the location. Typical NSAs include parks and wilderness areas.* DEIS at 3-197. The DEIS ignores noise impacts to wilderness areas. Wilderness areas proximate to the proposed withdrawal include Kanab Creek Wilderness, Mt. Trumbull Wilderness, Mt. Logan Wilderness, Paria Canyon-Vermilion Cliffs Wilderness, and Saddle Mountain Wilderness.	Impacts of mineral development on Wilderness, including noise, has been addressed in Chapter 4, Section 4.13 in a general way, Other than the 4 current mines, which are far enough away from any wilderness area that they have no effect, locations of the rest of the mines projected in the RFD are unknown. For this reason, detailed analysis of noise on any particular wilderness area is not possible. Future Mine Plans of Operation will be required to undergo site specific NEPA analysis prior to their approval. The NEPA process will require a determination of direct, indirect, and cumulative impacts specific to each mine location. Without specific information regarding the location, duration, and schedule of the operation of these

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				sources, no substantive estimates of the addition of cumulative noise can be presented in this level of evaluation.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	47	Soundscapes should not only be protected for people, they should also protect wildlife. According to the Organic Act [16 USC 1], the purpose of the National Park Service includes conserving "the wild life therein". Sound studies and modeling for the DEIS are weighted to represent human hearing. The DEIS should consider that wildlife can be harmed by sound disturbances. According to a recent sound study, humans will perceive an approximately 100-fold sound increase in some areas of Grand Canyon National Park, due to mining activities, but the actual measured sound in these locations will be 2000 times ambient sound (Ambrose 2010). This, for example, could impact bats, of which there are at least 20 species in Grand Canyon National Park, 10 being species of concern to one of the wildlife governing agencies (NPS 2010, pp. 22-24). Bats rely on sound to navigate and feed. If hibernating creatures are disturbed, they could expend more energy than they have reserved for the winter season, leading to mortality.	Effects of noise from the mine operations on wildlife were assessed in Chapter 4, Section 4.7, Fish and Wildlife. Future Mine Plans of Operation will be required to undergo site specific NEPA analysis prior to their approval. The NEPA process will require a determination of direct, indirect, and cumulative impacts specific to each mine location. Without specific information regarding the location and duration of the operation of these sources, no substantive estimates of the addition of cumulative noise can be presented in this level of evaluation.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	49	When combined with other sources of soundscape impairment in Grand Canyon National Park (i.e., aircraft), mining activities will unreasonably increase impairment of the park's soundscape. Low-level aerial surveys for mineral exploration have to be considered with the cumulative impacts from other aircraft flying over the Grand Canyon. (p. 4-197). Aircraft noise travels outward from the flight path and permeates deep within canyon environments, destroying wilderness character. Prospecting flights will spend extended time periods circling over or repeatedly passing a limited area, destroying recreational experiences for people who may be visiting the area only once in their lifetime.	Effects of noise on recreation activities was assessed in Chapter 4, Section 4.15. The cumulative effect of impacts of mining on soundscapes was assessed in Chapter 4, Section 4.10. Other than the 4 current mines, which are far enough away from the National Park boundary that they have no effect, locations of the rest of the mines projected in the RFD are unknown. For this reason, detailed analysis of noise on any particular area within the park is not possible. Future Mine Plans of Operation will be required to undergo site specific NEPA analysis prior to their approval The NEPA process will require a determination of direct, indirect, and cumulative impacts specific to each mine location. Without specific information regarding the location and duration of the operation of these sources, no substantive estimates of the addition of cumulative noise can be presented in this level of evaluation.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological	225279	50	The number of mines predicted under Section 4.10.9 Cumulative Impacts (p. 4-200) is far less than what is predicted in the Reasonably Foreseeable Future Activity (pp. 2-11 to 2-28). These numbers should be reconciled. When the true cumulative impact potential is recognized, Alternative B clearly emerges as the only alternative that will meet the DEIS needs.	Section 4.10.9 - Cumulative Impacts of the FEIS states "It is anticipated that a maximum of two mines would operate simultaneously in the North Parcel and that no more than one mine each would operate within the East and South parcels." This statement is meant to provide the reader with an "at any one time basis" of noise generation, which is different than the total proposed mine activities over the 20-year span of the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Diversity				proposed withdrawal. Please refer to Table 2.4-2 through 2.4-12, each of these tables provides an average number of mines operating on an annual basis.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	51	Nearly all activities recorded or modeled fail to meet EPA and Title 36 guidelines for maximum allowed sound levels. All activities reported on in Table 4.10-3 except the ore bucket and electric transformer exceed 69 dBA at 50 feet; all activities in Table 4.10-4 exceed 73 dBA at 50 feet; all activities in Table 4.10-5 except the transformer exceed 72 dBA at 50 feet. According to Table 4.10-4, the distance from exploration and development activities to achieve attenuation to ambient sound levels will be 0.9 to 2.3 miles (1.4 to 3.7 km) from the source of sound; according to Table 4.10-5, the distance from mining operation activities to achieve attenuation to ambient sound levels will be 0.4 to 1.5 miles (0.7 to 2.4 km), and the distance from ore hauling activities to achieve attenuation to ambient sound levels will be 1.4 miles (2.2 km). Therefore, several mines within a parcel could create an industrialized landscape where, after leaving the sounds of one mine, a visitor rapidly enters the soundscape of another mine. Networks of roads could distribute sound impacts throughout the North, East, and South Parcels. Since many people only visit the area once in their lifetime, this is an unreasonable impact, regardless of the total time that the impact persists. Table 4.10-6 identifies 72 percent of Grand Canyon National Park as being within an area where mining noise could be audible. Mining noise could be clearly audible (>6 dBA above ambient sound levels) in 39% of the park. Alternatives C and D could concentrate exploration and mining activities, but would not eliminate them. By moving exploration and development activities further from improved roadways, these alternatives could increase the distance travelled by every vehicle associated with exploration and mining activities, increasing the area receiving noise impacts from ore hauling and roadway improvement activities. This would spread noise impacts around a network of roads spanning the parcels.	The sound attenuation values provided in the EIS assume site conditions lack vegetation, elevated terrain or vertical structure that would have significant impacts on the distance noise would travel. The values associated with a specific mine development and operation would be modeled or measured based on the site specific conditions. The development and operation of each individual mine would require an evaluation of its impacts on the surrounding soundscapes. This evaluation would include parameters such as vegetative cover, terrain height, proximate vertical structures, etc. Haul truck and roadways would also be included in the site specific evaluation of impacts to the soundscapes. Impacts determined by this evaluation would be the basis for the establishment of mitigation measures imposed on the project to achieve levels consistent with regulation and policy. The individual mine seeking a permit to operate would be required to account for other background sources in the vicinity to determine the cumulative impacts on the soundscape. Figure 4.10-1 was added to Chapter 4 to further illustrate the area of influence when predicting potential impacts on the soundscape.
Quaterra Alaska Inc.	225288	12	The Perrin Ranch wind farm north of Williams AZ will be within full sight of route 64, the major route to the South Rim. It will consist of 62 wind generators which will be 480 feet high at the tip of the windmill blades. The blades will be moving and will presumably be white, which will enhance their visibility. It would be interesting to compare this to a single mine headframe 90 feet high which will be stationary and painted a color to blend in with the landscape, and would be a considerable distance from route 64. It would also be interesting to compare the noise of the windmill blades with the noise of a mining operation.	The purpose of this EIS is to estimate the environmental effects of the Proposed Action and Alternatives, mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. While comparison of the visual effects of a mining head frame to a windmill may be interesting, it is not relevant to the analysis being conducted. Visual impacts anticipated from the Proposed Action and Alternatives are analyzed in the EIS in Section 4.9.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Special Status Species				
American Clean Energy Resources Trust (ACERT)	225256	37	3.8.1 THREATENED, ENDANGERED, AND CANDIDATE SPECIES: RELICT LEOPARD FROG Page 3-153 Statement: *The species does not occur within the proposed withdrawal area. In Arizona, extant populations apparently are restricted to two general areas: Surprise Canyon in lower Grand Canyon National Park and Sycamore Spring, both in Mohave County (USFWS 2009a). However, according to USFWS (Brian Wooldridge, personal communication December 2009), the frogs in Surprise Canyon originally thought to be this species are actually lowland leopard frogs (Rana yavapaiensis). Relict leopard frog was introduced to Sycamore Spring in 2003. It also is present in Nevada at springs near the Overton Arm of lake Mead and springs in Black Canyon below Hoover Dam (USFWS 2009a). No relict leopard frogs are known from BIM lands on the Arizona Strip (BIM 2007). A historic population was found at a privately owned spring adjacent to the Virgin River at Littlefield, Arizona, but that population has since been extirpated (BIM 2007). Adult frogs inhabit permanent streams, springs, and spring-fed wetlands below approximately 2,000 feet amsl (USFWS 2009a). Relict leopard frog presumably feed on a wide variety of invertebrates (USFWS 2009a).* Comment: The key portion of this statement is that *"the species does not occur within the proposed withdrawal area.*" Why then would you add to the length of an already supersized DEIS with unrelated information? This is just one example. It would take too much time and space to respond to all the extraneous information you have included in these sections. Those "special" so-called environmental groups know the reason for the long list. The uranium industry knows the reason for that list as well. For the uninitiated concerned citizen who would read this document, the volume of nonsensical information stuffed into this section makes no sense at all and illustrates to the reader the vast amount of wasted time to include and the vast amount of money used to publish unneeded information.	The BLM is required by federal law to address federally listed threatened and endangered species as part of this NEPA analysis. Occurrence of T & E species is recorded at the county level. The project-specific NEPA analysis must therefore consider all listed species that occur in the county, although only those that may be affected by the project (both directly and indirectly) are analyzed in detail. The NEPA analysis must also study agency special status species and general wildlife as part of NEPA for the BLM, NPS, and Forest Service.
American Clean Energy Resources Trust (ACERT)	225256	39	SENSITIVE SPECIES: PLANTS Pages 3-160 - 163 Statement: *The species does not occur within the proposed withdrawal area.* Comment: To include all of the extraneous information about all of those plants that are NOT IN THE WITHDRAWAL area is irresponsible and completely misleading to the reader. Of the 14 plants listed, eleven are cited as not found inside the withdrawal area. Two are cited as being in House Rock Valley which basically is Grand Canyon Trust land and all can assume with great certainty that they were included at the request of that Trust.	BLM Manual Section 6840 provides policy and guidance, consistent with appropriate laws, for the conservation of special status species of plants and animals, and the ecosystems upon which they depend. These are species which are proposed for listing, officially listed as threatened or endangered, or are candidates for listing as threatened or endangered under the provisions of the Endangered Species Act (ESA); those listed by a State in a category such as threatened or endangered implying potential endangerment or extinction; and those designated by each State Director as sensitive. Conservation of special status species means the use of all methods

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				and procedures which are necessary to improve the condition of special status species and their habitats to a point where their special status recognition is no longer warranted.
American Clean Energy Resources Trust (ACERT)	225256	95	Pages 4-143 to 4-148 Under Alternative A the plants that are threatened are the Brady pincushion, sentry milkvetch, Fickeisen plains cactus, and Paradine (Kaibab) plains cactus (page 4-144). Under Alternative B the same plants would fall in the same category. It should be remembered that whereas Alternative A would have 30 mines over a 20-year period, Alternative B would still have 11 (a difference of 19). Comment: At the Carlota Mine in Arizona the mine had the hedgehog cactus that needed protection. The mine operator carefully removed each plant from its original location and replanted it in a special nursery area. After the mining is completed and the area is reclaimed, the plants will be replanted back in the ground. The same process was used successfully by Energy Fuels in the 1980s, and the same scheme can be readily followed at the uranium mines, since the area occupied by each mine is considerably smaller - only 20 acres each.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
American Clean Energy Resources Trust (ACERT)	225256	97	Pages 4-143 to 4-148 Comment: Under Alternative A the following could be impacted: relict leopard frog, northern leopard frog, lowland leopard frog, and Kanab ambersnail. 1. Those species that exist near the Colorado River, Little Colorado River, or Virgin River would not be impacted for the same reasons as given for the fish. 2.Those that are present in small seeps or ephemeral springs will not be impacted any more than with long droughts, drilling of water wells for public use, or other such activities.	The DEIS contains discussions on direct and indirect impacts to aquatic habitat in Section 4.8.3. It also references the reader back to Section 4.7 to previous discussions on the topic.
American Clean Energy Resources Trust (ACERT)	225256	98	Pages 4-143 to 4-148 Comment: Under Alternative A the humpback chubb and the razorback sucker are mentioned as fish that could be impacted in the Colorado River. The Little Colorado spinedace occurs in the Little Colorado River, which has a hydrologic connection in the South Parcel. In the Virgin River, the Virgin River chubb, virgin spinedace, and woodfin could be impacted. Comment: It has been pointed out earlier that the flow in the River is so large, average minimum of 1.6 million gpm (see page 4-79), that even a spill of 30 tons of high-grade uranium ore into the River will cause an impact that is "below the level of natural variation" (page 4-80). So the fish in the Colorado River would not be impacted. 2.The Canyon Mine well is located more than 5 miles south of the ground water divide. "The remaining mines could be assumed to be located several miles south of the groundwater divide in the Havasu Springs (flow about 29,000 gpm) groundwater basin and/or north of the groundwater divide in the groundwater basin that drains to the large Blue Springs (flow about 46,000 gpm) system along the Little Colorado River" (page 4- 73). Since these six mines would generate an average of 6 gpm, the impact would be negligible and not measureable. Hence the impact on the fish would also be negligible. 3.The DEIS states (page 4-72): "Considering the lowest of	The BLM is required by federal law to address federally listed threatened and endangered species as part of this NEPA analysis. Occurrence of T & E species is recorded at the county level. The project-specific NEPA analysis must therefore consider all listed species that occur in the county, although only those that may be affected by the project (both directly and indirectly) are analyzed in detail. The NEPA analysis must also study agency special status species and general wildlife as part of NEPA for the BLM, NPS, and Forest Service. The species associated with the virgin river have been included in the analysis because they occur on the USFWS Mohave County list and because the North parcel does have a hydrologic connect and impacts, no matter how minor, may occur and required to be discussed.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the reported aggregate spring flow rates (9,000 gpm) and even assuming that all 21 mines anticipated under Alternative A for the North Parcel would be located within the Virgin River groundwater basin (total mine pumping of 21 gpm over a 20-year period of this analysis), the maximum calculated decrease in the discharge would be 0.5%, which is negligible and not measurable." This implies that the fish in the Virgin River will not be impacted.	
American Clean Energy Resources Trust (ACERT)	225256	99	Pages 4-143 to 4-148 Comment: Under Alternative A the birds of prey that require special attention are the bald eagle, California condor, Mexican spotted owl, and American peregrine falcon (page 4-144). Near Kanab Creek the southwestern willow flycatcher might be found and near the Virgin River the Yuma clapper rail is found. Under Alternative B the same birds would be affected in the same manner. It should be remembered that whereas Alternative A would have 30 mines over a 20- year period, Alternative B would still have 11 (a difference of 19). The monitoring rules that Denison needs to follow at their operations on the Arizona Strip include "The Operator will report local sightings of falcon or eagle to the BIM. Upon such a sighting, no employee will harass, harm or injure the species." In fact, if these are sighted the BIM or organizations that deal with such birds need to be notified and they would take the appropriate steps to have the bird leave the area. Similar clauses will no doubt be included in any permits granted for future mines. Note that each new mine would have to have its own sitespecific EIS. The DEIS outlines the precautions to be taken for California condors and the Mexican spotted owl (pages 4-148 and 4-149). Similar precautions would be implemented for other birds that require special attention.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plan.
Energy Fuels Resources	225260	11	I disagree that a major long-term impact could occur to special status species under Alternative A. I could not find any mention of a "major long-term impact" in Section 4.8, which provides the detailed analyses for these species.	Section 4.8.3 of the DEIS contain discussions regarding the magnitude of these impacts. In some instances the language used in the definition the other terms minor, moderate, or major were used. The Executive Summary states that alternative A will have potential minor to major long term impacts. Because we couldn't fully gauge where the mine locations would be in relation to springs and seeps, we chose to include impacts to include 'major' in the Executive Summary.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon	225279	26	The cumulative effects analysis in the DEIS for threatened, endangered and candidate species is inconsistent with its analysis of direct and indirect effects. In its discussion of Alternative A, the DEIS cites potential impacts to amphibians and aquatic invertebrate species: *Impacts to riparian habitats and water quality could affect several amphibian species and an aquatic-dependent invertebrate. These species include the relict leopard*	The DEIS contains a discussion on aquatic habitats and special status species in Section 4.8.3. Section 4.8.3 also references "For a more detailed discussion on aquatic and terrestrial habitat impacts, see Sections 4.7 and 4.7.4."

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Chapter, Center for Biological Diversity			*frog, northern leopard frog, lowland leopard frog, and Kanab ambersnail. The location of the mine facility and the influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs could influence the magnitude of these impacts on these amphibian and invertebrate species*. DEIS at 4-145. It also cites potential impacts to birds under Alternative A: *Birds may be injured or killed by collisions with vehicles traveling on the road system. Birds of prey, including bald eagle, California condor, Mexican spotted owl, and American peregrine falcon, may be impacted by physical land disturbances associated with mining and increased risk of injury as a result of traffic power lines. Impacts to riparian habitats and water quality anywhere within the proposed withdrawal area could impact these bird species, as well as the southwestern willow flycatcher, found along Kanab Creek (North Parcel), and Yuma clapper rail, found along the Virgin River* DEIS at 4-145. The DEIS does not discuss the potential for uranium mining to impact endemic aquatic species by depleting or contaminating water feeding springs. Instead, the BLM simply references its own Resource Management Plan. *Actions that degrade riparian habitat or reduce the potential of the area to support riparian vegetation will be modified, restricted, or prohibited (BLM 2008b). No net oss will occur in the quality and quantity of suitable habitat for endemic fish, amphibians, and aquatic invertebrate species (BLM 2008b).* DEIS at 4-119. Because BLM cannot guarantee that uranium mining will not contaminate or deplete springs feeding springs that are sources for endemism, BLM cannot simply conclude that the existence of its Land and Resource Management Plan precludes impacts to endemism. To the contrary, the depletion or contamination of seeps and springs has the potential to impact endemic species. Seeps, springs and caves whose water uranium mining could impact could harbor endemic species not yet known to science. Long-term changes in water quality and quantity feeding springs has the potential to extirpate or retard the persistence and continued evolution of endemic species	
	242652	4	If proposed mines impact T&E species, and consultation is initiated with the US Fish and Wildlife Service, how will you ensure that the wildlife agency addresses cumulative impacts to a given species from multiple mines? The Service is not required to look at reasonably foreseeable events so could ignore mines that are planned, but not yet constructed. The agency also has been known to limit its analysis to a subpopulation that it renders as "expendable" in order to arrive at a non-jeopardy opinion for a particular proposed project while ignoring cumulative impacts across the range of a species.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
The NAU	242913	92	Conservation Measures page 147. The following general measures must	The purpose of the EIS is to analyze the effects of the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Project, LLC			be applied to federally listed species in the proposed withdrawal area: All surface-disturbing activities would include conservation to reduce impacts to special status species and their habitat. Conservation measures developed for each listed or proposed species would be applied to any proposed project within the habitat of that species. Analysis of impacts and determinations of effects would include any and all mitigation and conservation measures. What might these be? An example list? Are they effective? Are they SOP?	Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Fish and Wildlife Service	242660	6	Page 2-39, Table 2.8-1, Special Status Species: In addition to the impacts listed, there may also be direct impacts to these species resulting in disturbance, injury, or death of individuals, particularly plants, from exploration and mine-development activities.	Section 2.8 of the EIS has been updated to include discussions of magnitude of impacts in relation to location of mines and special status species, including vegetation under this category.
U.S. Fish and Wildlife Service	242660	8	Page 3-7, Table 3.1-1: The table does not consider potential effects to special status plants. These may include mortality or injury to individual plants from crushing or removal, and loss or modification of habitat through actions such as clearing and road construction. The proportion of habitat modified or lost is an additional indicator for the special status species population section; the number of special status plants lost as a result of mine development is an indicator for the special status species mortality section.	Section 3.1.7 of the EIS has been updated to include discussions regarding direct impacts from physical alterations and crushing.
U.S. Fish and Wildlife Service	242660	9	Page 3-130, Table 3.8-1: The only designated critical habitat for California condor is in California; there is no critical habitat in the project area. There is no conservation agreement for this species. The California condor in the project area is designated as a nonessential experimental population under section 1 O(j) of the Endangered Species Act (ESA).	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	10	Page 3-130,3-132, Table 3.8-1: Yellow-billed cuckoo and Fickeisen plains cactus are listed in the table as "Candidate w/o CH". Critical habitat is not designated until a species becomes federally-listed as threatened or endangered, so the reference to critical habitat for these candidate species should be removed.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	11	Page 3-135, Table 3.8-1: The Virgin River chub co-exists with woundfin and Virgin River spinedace, and therefore, for consistency with these species, should also be listed as being in close proximity to the parcels.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	12	Page 3-136, Table 3.8-1: The Mojave desert tortoise does not occur in close proximity to any of the withdrawal parcels.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	13	Page 3-137, Table 3.8-1; Page 3-158: The Niobrara ambersnail (Oxyloma haydeni haydeni) is included as a federally-listed species in the table and the text in this section. The federally endangered entity is the Kanab ambersnail (Oxyloma hyadeni kanabensis). The Niobrara ambersnail is not	Section 3.8.1 has been updated to include this species information.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			federally-listed and is not a federal candidate for listing.	
U.S. Fish and Wildlife Service	242660	14	Page 3-139, Table 3.8-2: The northern leopard frog should be included as "Possible" for the East Parcel. Populations occur near the boundary of the East Parcel in the House Rock Wildlife Area.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	15	Page 3-140, Sentry milk-vetch: The species description contains a number of inaccuracies. Please refer to our recent 5-year status review of this species for more accurate information (http://www.fws.gov/southwest/es/arizonaiDocuments/SpeciesDocs/Sentryi Sentry%20MilkVetch%205-Year%20Review.pdf).	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	16	Page 3-143, Paradine (Kaibab) plains cactus: We recommend obtaining more recent monitoring information than what is provided here (2000), which is available from Barb Phillips, U.S. Forest Service.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	17	Page 3-144-147, California condor: To update the information provided here, as of March 31, 2011, there are a total of 193 condors in the wild population, 73 of them in Arizona. Birds have only been released at Vermillion Cliffs (no releases at Hurricane Cliffs). Breeding activity has occurred at the locations mentioned, but not all these nests have been successful. Lead contamination from hunter-killed carcasses continues to be a major factor affecting the reintroduction program.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	18	Page 3-147, Yuma clapper rail: The Yuma clapper rail has been found in the Virgin River above Lake Mead since 1998.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	19	Page 3-150, Mexican spotted owl: The discussion of critical habitat should cite the 2004 Final Rule (Federal Register 69:53182-53298). The description in this section should include canyon type critical habitat, which constitutes most of the critical habitat in Critical Habitat Unit CP-1 0, as well as in the vicinity of the proposed withdrawal.	Section 3.8.1 of the DEIS contains discussions of these habitat types.
U.S. Fish and Wildlife Service	242660	20	Page 3-151, Bald eagle: The last sentence is incorrect. The bald eagle is no longer listed as a threatened species under the ESA, Federal agencies do not manage it as if it is a proposed species, and it is not afforded protection under the ESA. However, the bald eagle remains protected under the BGEPA.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	21	Page 3-151, Peregrine falcon: Similar to the comment above, the peregrine falcon is not afforded protection under the ESA as a listed species. It remains protected under the MBTA.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	22	Page 3-153, Desert tortoise (Mojave population): Ernst and Lovich (2009) contains a comprehensive overview of the diet of the desert tortoise. Desert annuals, particularly forbs, are the primary food source for Mojave desert tortoise, and grasses are considered to be secondary in importance.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and	242660	23	Page 3-154, Northern leopard frog: The email cited was from Shaula	Section 3.8.1 has been updated to include these

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Wildlife Service			Hedwall, not "Durst". The citation provided in that email is "Drost 2010". Furthermore, this paper describes the northern leopard frog as occurring along the Colorado River at Horseshoe Bend (River Mile 9) until 2002.	changes.
U.S. Fish and Wildlife Service	242660	24	Page 3-155, Humpback chub: Within the Lower Colorado River Basin, critical habitat has been designated in the Little Colorado River from river mile 8 to its confluence with the Colorado River, and in the Colorado River from Nautiloid Canyon to Granite Park.	Section 3.8.1 of the DEIS contains discussions of this information.
U.S. Fish and Wildlife Service	242660	25	Brian Healy is a National Park Service biologist, not a U.S. Fish and Wildlife Service employee.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	26	Page 3-155, Razorback sucker: Critical habitat for this species has also been designated in the Colorado River from the Paria River to Hoover Dam.	Section 3.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	27	Page 3-156, Virgin River chub: Based on sampling conducted in 2010, the Virgin River chub currently occurs in the Virgin River in Utah and Arizona. It is occasionally documented in the river in Nevada.	Section 3.8.1 of the DEIS contains discussions of this information.
U.S. Fish and Wildlife Service	242660	28	Page 3-181, Resource condition indicators: Please see our comment above for page 3-7.	Section 3.8.6 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	44	Pages 4-139 to 141, Table 4.8-1: For species with designated critical habitat, the rationale for exclusion should state that no critical habitat would be affected and include the reason(s). In addition, on December 14, 2010, FWS published a 12-month "warranted but precluded" finding for the Sonoran population of the desert tortoise. This subspecies is now a candidate for listing under the ESA.	Section 4.8.1 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	45	Page 4-143, Section 4.8.3, Threatened, endangered, and candidate species: This paragraph implies that ACECs fully protect the species that are located within them. Although ACEC designation provides certain protections, mining activities can still occur within ACECs and result in impacts to these species.	Section 4.8.3 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	46	Page 4-144, Impacts of Alternative A: Siler pincushion cactus could be affected in a manner similar to the other plants listed here.	Section 4.8.3 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	47	Page 4-145, Impacts of Alternative A: Northern leopard frog and lowland leopard frog are not currently threatened, endangered, or candidate species and should be included with the description of impacts to sensitive species instead of in this section.	Section 4.8.3 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	48	Page 4-147, Cumulative impacts: In the sentence regarding critical habitat for the Mexican spotted owl, please clarify that this habitat is withdrawn from mineral entry due to other withdrawals (such as wilderness designation). Critical habitat designation itself does not withdraw these areas from mineral entry.	Section 4.8.3 has been updated to include this species information.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
U.S. Fish and Wildlife Service	242660	49	Page 4-147, The ESA requires consultation for Federal actions that may affect listed species or designated critical habitat and is intended to avoid or minimize adverse effects. However, the ESA does not require that effects result in "minor and less than significant cumulative impacts." The ESA does prohibit Federal agencies from implementing actions that would result in jeopardizing the continued existence of a listed species or adversely modifying or destroying critical habitat.	Section 4.8.3 has been updated to include this species information.
U.S. Fish and Wildlife Service	242660	51	Page 4-148 to 149, California condor: We recommend adding a conservation measure that requires covering truckloads, bins, and/or piles of wet or dry uranium ore or bypro ducts while on site and not actively being used or monitored. The purposes would be to reduce contamination off-site from blowing dust as well as discourage perching/roosting by condors and other avian species.	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Fish and Wildlife Service	242660	53	Page 4-149, Mexican spotted owl standards: We recommend also conducting surveys in canyon type habitat that may support Mexican spotted owls within 0.5 mile of proposed mining activity.	Section 4.8.1 of the DEIS contains discussions of this information.
Havasupai Tribal Council	54408	2	Given the presence of endangered and threatened plant and animal species, how would Alternatives C, D, and the "no action" Alternative adequately protect the endangered and threaten species that occupy the proposed withdrawal area?	Section 4.8 of the DEIS contains discussions that disclose potential impacts on threatened and endangered species of all the proposed alternatives, including Alternatives A, C and D.
Vegetation Resources				
Donald Begalke	225254	7	What would be the losses in total tree-numbers, in shrubs (removed), in scraped-away grasses etc? This Draft fails to present the details on such habitats' losses, and I respectively request those details to be included in this project's Final EIS.	The potential impacts of the proposed project alternatives on vegetation resources is quantified in the Draft EIS in terms of acres of vegetation cover type that would be removed. This is a more accurate measure to assess the context of the impacts to vegetation because quantifying numbers of trees or individual grass plants is impossible at this scale due to the high variability between different areas, combined with the fact that the specific locations of future mining locations are unknown. Presenting impacts in acres disturbed also extrapolates better for the analysis of impacts to wildlife habitat. The number of individual plants disturbed is only meaningful in a discussion on special status plants, within the analysis of a particular mining plan of operations, rather than in

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				this analysis of the impacts of the proposed withdrawal.
	225254	8	Other than plugging drill holes and surface maintenances, more on reclamations of habitats where mineral explorations fail must be included in assessments also. The exploring companies, failing to find minerals, must submit bonds to federal agencies for reclamations, and repairing acres and acres of lost habitats from unneeded roads and at failed-exploration sites. Soils, trees, vegetations et al must be restored on/within Public Lands, paid for by the bonds. The economics must be discussed in the final presentation of this proposed withdrawal.	Section 4.6.2 discusses site specific operational requirements and conditions. The federal agencies require reclamation plans and bonding for each mining or exploration project.
Energy Fuels Resources	225260	9	I disagree that a major long-term impact could occur to aquatic and terrestrial habitats under Alternative A. I could not find any mention of a "major long-term impact" in Sections 4.6 and 4.7, which provide the detailed analyses for vegetation and fish and wildlife.	Sections 4.6 and 4.7 of the Draft EIS describe the rationale and background for the impacts descriptions. Section 4.6 describes impacts ranging from minor to moderate. Section 4.7 describes impacts ranging from minor to major.
Uranium Watch	225262	37	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The DEIS discussion of Impacts Common to All Alternatives (Section 4.2.4, page 4-16) manages to totally ignore the radioactive and hazardous constituents of any fugitive dust from the mining operation. The EIS must identify all hazardous radioactive and non-radioactive constituents of fugitive dust from the uranium mining operations and assess their impact on the environment. This would include an evaluation of potential exposure pathways and impacts to the public, workers, ground and surface water, soils, vegetation, and native and domestic animals over the short and long term.	Section 4.6.1 of the Draft EIS discloses the impacts of fugitive dust, including potential radio-active and non-radioactive issues.
Uranium Watch	225262	72	Section 4.6.2 Compliance with Environmental Regulations and Permitting (page 4- 115) assumes that appropriate construction and conservation measures will be taken during mine development and operation. This is an unsupported assumption because the state and federal agencies do not regularly inspect construction operations and do not enforce their regulations.	The BLM does monitor mining activities that occur on BLM-administered lands. The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within the BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, and National Park Service have agreed to initiate formal talks with ADEQ so that all four agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.
Uranium Watch	225262	73	Section 4.6.2 assumes that revegetation of disturbed areas will take place in a timely manner. Again, this has not been the experience on BLM land in La Sal. Disturbed areas have not been reclaimed as indicated in the plans of operation, and there is un-remediated erosion from access road construction that has not been addressed for many years. In some areas no attempt has been made to control or eliminate erosion on the access roads that are no longer in use. This erosion prevents the reestablishment	The BLM does monitor mining activities that occur on BLM administered lands. The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, and National Park Service have agreed to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			of vegetation in disturbed areas.	initiate formal talks with ADEQ so that all four agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.
Uranium Watch	225262	74	Section 4.6 should discuss the impacts to vegetation from the uptake of radon progeny from the emission of radon from the mine portal and mine vents. Radon progeny are scavenged by water and vegetation, particularly in the immediate vicinity of the portals and vents.	Section 4.6.1 of the FEIS has been revised to include a more detailed discussion on impacts to vegetation from the uptake of radon progeny from the emissions of radon from the mine facilities.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	33	The DEIS fails to acknowledge the link between increased public and industrial access to wildlands resulting from road construction for exploration and mining, and resulting increased incidence of invasive weed spread, fire, and synergies thereof. Roads for exploration and mining would facilitate vehicle and off-road vehicle access into wildlands thus providing new vectors for weed spread. Increased public and industrial access will also facilitate increased incidence of human-caused fires. The DEIS also fails to acknowledge the strong link between the spread of invasive species, particularly cheatgrass, and fire, and the consequence of continued spread and eventual type conversion resulting from the cheatgrass fire cycle.	Section 4.6.1 has been updated to include more detailed discussion regarding cheatgrass and other invasive species and the potential increase for fire from these invasive species communities when compared to more natural vegetation communities.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	34	The DEIS states: *Impacts to the vegetation resource could result in reduced biological productivity, weed invasion, and unwanted changes in the composition and structure of vegetation communities. These changes, in turn, could influence forage availability for wildlife and livestock. Where actions result in loss or reduction of vegetative cover and/or soil erosion or compaction, cultural, wildlife, water, soil, and air resources could be impacted. DEIS 4-113.* Loss of forage availability is not the only consequence of impacts to vegetation resources. Wildlife also use vegetation for habitat cover and may depend on vertical structure to evade predation. For example, this would be important for pronghorn antelope in the North and East parcels. Perhaps more importantly, the analysis neglects to acknowledge the influence of non-native species such as bromes, Russian thistle, and medusahead on fire regimes. Spread of these species increases the probability of fire, which will likely lead to additional spread and additional fire.	Section 4.7 of the FEIS has been revised to provide additional information regarding the potential indirect impacts of changes in vegetation composition on cover and other factors affecting wildlife species. Sections 3.6.2 and 4.6.1 discuss invasive species impacts associated with the proposed project.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	35	The DEIS states: *The time required for successful reclamation would depend on soil, topography, rainfall, vegetation type, and the reclamation method used. DEIS 4-114.* This statement assumes that it is possible to successfully reclaim areas. This is not necessarily the case, particularly in the most arid regions of the withdrawal area and over the large acreages where surface disturbance would occur. Reseeding arid lands is extremely difficult. The EIS should include an assessment of the viability of reclamation in arid lands to more accurately determine whether reclamation to established benchmarks is truly possible. Beyond this	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. However, as a result of this EIS and interest in developing protections for the environment, a comprehensive Best Management Practices and Monitoring Plan to address

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			invasive species such as cheatgrass, Russian thistle, Russian knapweed, medusahead, and others are extremely difficult to control and an assessment of the viability of controlling these species should also be conducted to identify the probability of successful reclamation. Also, mining companies should be held accountable for providing resources to continue reclamation activities until benchmarks for success are achieved.	impacts of future uranium mining in the withdrawal area is being prepared. This plan will be developed by involved federal and state agency experts and address pertinent environmental concerns and outline a long-term monitoring strategy for the area. The plan will be implemented through current BLM and Forest Service procedures. The BLM does monitor mining activities that occur on BLM administered lands. The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, and National Park Service have agreed to initiate formal talks with ADEQ so that all four agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	36	The DEIS states: *Preventive measures, such as power washing of all construction vehicles prior to their entry onto construction sites and monitoring reclamation sites, would minimize establishment and spread of invasive species as part of reclamation activities.* DEIS 4-116. If that's true, these activities should be included in the list in 4.6.2. in the section titled "Compliance with Environmental Regulations and Permitting." Also, while these activities could potentially reduce spread, they would not "minimize" it because powerwashing immediately off-site would simply deposit seeds on public land adjacent to said sites (in wash-water that could facilitate weed establishment); this does not preclude establishment and subsequent spread of invasive plants. Moreover, monitoring does nothing to minimize establishment and spread.	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, and National Park Service have agreed to initiate formal talks with ADEQ so that all four agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park. Power washing to remove plant and see materials from equipment will occur at an offsite washing facility and not on adjacent lands. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Grand Canyon Wildlands	225279	37	As indicated above, this analysis does not acknowledge the strong linkages between spread of invasive species, particularly cheatgrass, and	Section 4.6.1 discusses invasive species. Vegetation impacts were calculated for more than the physical

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity			fire, and the consequences of continued spread and eventual type conversion that are part of the cheatgrass fire cycle. Thus, the cumulative impacts to vegetation are underestimated, as they are unlikely to be solely limited to areas where surface disturbance has occurred in the instances where they facilitate the spread of fire to adjacent parts of the landscape.	footprint of the mine and roadways. In addition a 0.5 mile impact zone for indirect vegetation and wildlife habitat impacts are discussed in Section 4.7.4. Section 4.6.1 of the FEIS has been updated to include more detailed discussion regarding cheat grass and other invasive species and the potential increase for fire from these invasive species communities when compared to more natural vegetation communities.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	38	The following citations speak to the strong connection between fire risk and cheatgrass. (see submittal #225279 for complete citation list.)	References were reviewed. Section 4.6.1 discusses invasive species. Section 4.6.1 has been updated to include more detailed discussion regarding cheat grass and other invasive species and the potential increase for fire from these invasive species communities when compared to more natural vegetation communities.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	39	The DEIS analysis omits several narrowly-endemic plant species of the Grand Canyon region or plant species whose genetics are poorly understood. All of these species may occur in the withdrawal area and could be impacted by ground disturbing activities relating to mining or exploration (Table 1). (see submittal #225279 for complete list.)	The commenter provided a list of species classified as “narrowly endemic plant species” but does not provide a reference for this list. The EIS utilizes the most current list from the USFWS, AGFD, BLM, Forest Service, and NPS for analysis. No updates required.
American Clean Energy Resources Trust (ACERT)	225256	90	Pages 4-115 to 4-116 Comment: The discussion on vegetation resources mentions that these include structure, productivity, vigor, abundance, and diversity. However, there is considerable uncertainty about these parameters since the specific sites are not known. 1. This uncertainty is not reflected in the Summary Table 2.8-1, which could result in certain readers being misled. 2. The discussion does not point out that activities un-related to uranium mining, such as fuels management, noxious weed control, wildfires, droughts, cattle grazing, recreational activities (developing roads, trails, campgrounds), installation of water and power lines, development of private lands, drilling for oil, gas, or water, fluid mineral leasing, mining on leased or sold lands (sand and gravel, copper, stone quarrying) may actually have a much greater impact. The land is not being withdrawn from these activities. 3. No mention is made to plants that require special attention. These are dealt with under Section 4.S, Special Status Species. Some reference to this would be appropriate in Section 4.6. Vegetation Resources.	1) Table 2.8.1 is a summary table. Full impacts discussions are contained in Section 4.6, 4.7 and 4.8. 2) Cumulative impacts are addressed in Section 4.6.7. In addition, the land use items discussed in are discussed in the Agency land use management plans and associated NEPA documents. 3) The reference that this comment is requesting is actually in Section 3.6. Section 4.6 has been revised to include a reference to where discussion on vegetative special status species are discussed.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
American Clean Energy Resources Trust (ACERT)	225256	91	Pages 4-116 to 4-117 Comment: The discussion on vegetation resources mentions that these include structure, productivity, vigor.abundance, and diversity. However, there is considerable uncertainty about these parameters since the specific sites are not known. 1. This uncertainty is not reflected in the Summary Table 2.8-1, which could result in certain readers being misled. 2. The discussion does not point out that activities un-related to uranium mining, such as fuels management, noxious weed control, wildfires, droughts, cattle grazing, recreational activities (developing roads, trails, campgrounds). Installation of water and power lines. Development of private lands, drilling for oil, gas, or water, fluid mineral leasing, mining on leased or sold lands (sand and gravel, copper, stone quarrying) may actually have a much greater impact. The land is not being withdrawn from these activities. 3. No mention is made to plants that require special attention. These are dealt with under Section 4.8, Special Status Species. Some reference to this would be appropriate in Section 4.6. Vegetation Resources.	1) Table 2.8.1 is a summary table. Full impacts discussions are contained in Section 4.6, 4.7 and 4.8. 2) Cumulative impacts are addressed in Section 4.6.7. In addition, the land use items discussed in are discussed in the Agency land use management plans and associated NEPA documents. 3) The reference that this comment is requesting is actually in Section 3.6.
Groundwater Awareness League, Inc	242658	2	While the BLM comprehensive report includes a surprising amount of data on the water in this isolated region, it does not explain how the trees and vegetation are sustained. With water levels at 2,000 ft. obviously, it is not from groundwater. Therefore, it must be from rain and snow, that is, surface water. Exactly what is the number of valuble trees that will be destroyed by the proposed mining operations? If in-situ mining methods are used, how will that effect the surrounding habitat.	This comment is beyond the scope of this analysis. Unable to calculate the specific numbers of trees removed because specific mine locations are not known.
		4	It is impossible to keep a stable solution in the dissolved radiation in the in-situ wells. Therefore, the uranium that was mostly bound up in pipes is now released. What will be the effect on the surronding trees and vegetation?	Section 4.6.1 has been revised to provide additional information on direct impacts from mine portals and vents include possible emissions of radon in the general vicinity of these mining features. The mining process is underground ore removal mining, not “in-situ” solution mining, there are no “in-situ” wells associated with this EIS.
The NAU Project, LLC	242913	88	Compliance with Environmental Regulations and Permitting page 4-115 *2. All new temporary or existing upgraded roads on BLM lands may require mitigation to reduce the potential adverse impact of fugitive dust as specified by the authorized officer.* What might these be?	Section 4. 2 (Air Quality and Climate) includes examples of standard mitigation measures to reduce impacts associated with dust from hauling ore under the subsection titled Compliance with Environmental Regulations and Permitting.
U.S. Fish and Wildlife Service	242660	7	Page 3-2, Section 3.1.2: The scientific name for Siler pincushion cactus is Pediocactus sileri. The scientific name for southwestern willow flycatcher is incorrect; the correct name is Empidonax traillii extimus.	Section 3.1.2 has been updated to address this comment. Main body text was correct. Change in text was made from (*Strix occidentalis lucida*) to (*Empidonax traillii extimus*).
U.S. Fish and Wildlife Service	242660	29	Page 4-116, Impacts of Alternative A: Although individually fairly small areas would be disturbed under this alternative, the number of exploration (504) and mining projects (21) anticipated for the North Parcel could result	Section 4.6.3 has been updated to discuss long term impacts for the North Parcel in more detail.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			in long-term and apparent differences between the disturbed then reclaimed areas and the surrounding vegetation. Impacts are more likely to be apparent to the vegetation community overall in this parcel because of the total number and acreage of disturbances that could be distributed throughout the parcel, and because successful reclamation to the pre-disturbance community and condition is unlikely, due to the highly variable precipitation, invasive plants species, and existing land uses.	
U.S. Fish and Wildlife Service	242660	30	Page 4-118, Impacts of Alternative D: Similar to our comment above, impacts to vegetation within the North Parcel in this alternative would likely be similar to those in Alternative A, due to the relatively high number of exploration action (290) and mines (20) that would be concentrated across a smaller area.	Section 4.6.6 has been updated to discuss long term impacts for the North Parcel in more detail.
U.S. Fish and Wildlife Service	242660	32	Page 4-118-119, Cumulative impacts: Livestock grazing can also slow recovery of vegetation after disturbance and impact the success of reclamation, especially at sites that are near stock tanks or corrals where cattle congregate. We recommend protecting disturbed sites from grazing to improve the opportunity for successful revegetation to the pre-disturbance conditions.	Section 4.6.7, Cumulative Impacts, includes a discussion on livestock grazing. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
U.S. Fish and Wildlife Service	242660	34	Page 4-127, first full paragraph: An additional effect at mines under interim management, as well as active mines, is exposure of birds and bats to contaminated water that periodically occurs from rainfall events at mine collection ponds. Requiring netting or other protection over these ponds would reduce the chance of contamination and potential injury to migratory birds and bats.	Section 4.7.3 has been updated to include discussion of rain events.
Arizona Game and Fish Department	242655	3	The Department is concerned that increased activity in the area may lead to the proliferation of invasive plants which in turn leads to reduction in habitat quality. An example of invasive plants spreading in remote areas comes from Tyser and Worley (1992) who found that although invasive plants were more common along primary roads, they were also prevalent along secondary roads and trails in remote grasslands. The Department is particularly concerned about large scale infestations of species like cheat grass. Cheat grass and other Bromus spp are already established within all three parcels and proliferation of these non-native grasses has the	Section 4.6.2 has been updated to include more detailed discussion regarding cheat grass and other invasive species and the potential increase for fire from these invasive species communities when compared to more natural vegetation communities.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			potential to influence fire regimes and drastically reduce important wildlife forage such as cliffrose, sagebrush, and four-wing saltbush.	
Hualapai Tribe-Office of the Chairman	225270	30	Vegetation Species of Concern Kaibab Agave. Kaibab agave (Agave utahensis var. kaibabensis) is found in proximity to the three proposed sites, is a Grand Canyon National Park Service species of concern and is a species of cultural significance to Hualapai. Damage to Kaibab agave species is a threat to Hualapai cultural integrity and perseverance. The persistence of healthy agave communities ensures a continuation of harvesting practices and uses evidenced as in recorded pre-colonial and contemporary practices.	Section 3.8.4 includes discussion on this species and it is discussed in a group in Section 4.8.6.
Visual Resources				
Derek Holmgren	4622	3	Was light pollution examined using National Park Service (NPS) criteria? I recommend checking with the NPS. A good place to start: http://www.nature.nps.gov/air/lightscapes/	National Park Service data was used in describing existing Night Sky conditions in the National Park (Night Sky Quality Monitoring Report [2006a]). The website the commenter references provides general parameters the NPS uses to monitor night skies and attempt to differentiate between existing natural and human-created light in the night skies. However, it does not provide methodology or criteria for quantitatively predicting the impacts of development on sky glow. The potential impacts on night skies from the proposed project were evaluated qualitatively and took into account factors recognized by the NPS and other agencies as contributing to light pollution. See the night sky discussion in Sections 3.9.5 and 4.9.2.
Derek Holmgren	4622	8	I disagree with the following: Page 4-177, Regional Haze and Dust states: *Under Alternative A, these impacts would be moderate to major and short term.* These impacts would be caused by mining operations and truck traffic. These activities would occur during the lifespan of the project and, therefore, the impacts should be considered long term as there will always be casual observers, persons traveling along area roads, recreationists, etc. in the area to view these impacts. Although mining operations and truck traffic may not occur every hour of every day, the fugitive dust will linger long enough for there to be long term impacts.	Section 4.9 of the EIS has been edited to address the duration of impacts to reflect the commenter's concern that the duration of impact is long term.
Derek Holmgren	4622	9	Page 4-177, Night Sky states: *Under Alternative A, these impacts are classified as short-term and moderate.* These impacts would be caused by lights on mining equipment and truck traffic. The lights associated with these activities would be present during the lifespan of the project and, therefore, the impacts should be considered long term as there will always be casual observers, persons traveling along area roads, recreationists, etc. in the area to view these impacts. Also, these activities would occur in areas that currently have no sources of artificial light. Introducing this much	The definition of long-term impacts for Visual Resources is provided in Table 4.9-2. Breccia pipe uranium mines, as analyzed in this EIS, operate for 5 years. Using the definitions given, night lighting duration is considered "short-term." The magnitude definition of moderate is included in Table 4.9-1. The impact assessment remains moderate, given the magnitude definition and the night lighting design

Table 5.6-4. Response to Comments (Continued)

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			light to areas with no light would have a major impact, not a moderate impact. A moderate impact would occur if lights from mining activities were introduced to an area that already had some sources of artificial light, or if the introduced light was negligible in terms of quantity, intensity, and visibility.	currently used on uranium mines in the area.
American Clean Energy Resources Trust (ACERT)	225256	101	Pages 4-163 to 4-189 Page 2-40, Table 2.8-1 *Statement: Entire Section* Comment: Under Alternative A there will be visual impact of a headframe which stands 40 feet high, during mine development and production. Otherwise the area occupied by each mine is only 20 acres, which is small compared to the overall withdrawal area of over 1+ million acres. The headframe would be standing for about four years for each mine. There may be as many as six mines in operation at anyone time over the three parcels. 1. The discussion deals with the visibility of a mine headframe or exploration rig from various viewpoints. It should be noted that the mine locations will change every four or five years. Further, the discussion does not mention the number of persons that would use that viewpoint during that period. So the probability of having one's view obstructed by a mine is very small. 2. It would only be if the mine was located at a high point that the mine would be visible from one of the viewpoints in the Grand Canyon National Park where the number of visitors is large. Since each new mine would be subject to rigorous scrutiny under a site-specific EIS, this would probably not be permitted unless strict mitigation procedures were included in the mine plan of operations.	The visual resource impact analysis takes into account the factors of unknown precise mining operation locations and the probability of operations located within a particular visual resource management class. It does not take into account visitation to particular Key Observation Points (KOPs) because that visitation is highly variable and impossible to accurately predict into the future. Accordingly, the analysis is based on impacts to key sensitive viewsheds seen from KOPs, not on the numbers of visitors that could be impacted if they visit those KOPs. Additionally, the extent of area that mining exploration and operations are visible from KOPs in visually sensitive areas is provided in Figures 4.9.1 through 4.9.6 of the Draft EIS.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	43	The DEIS Should Acknowledge Its Underestimation of Impacts. Effects on Visual Resources are based on consideration of the viewshed from roadways, popular scenic viewpoints (Key Observation Points), and trailheads. While the viewsheds from these locations are an integral part of the regional visitor experience, they fail to protect those who pursue backcountry experiences. Those who venture away from major roadways in pursuit of untrammeled landscapes are the most likely to be perturbed by visual intrusions from mining and exploration activities. Power lines and roadways are linear impacts that span great distances and are difficult to mask. They change the form, line, color, and texture in the viewshed as they bisect the landscape; dust rising from roadways can increase their detectability; lights, even if they point downward, will be more visible to those participating in backcountry camping away from other developments, or night hikes.	The analysis of Conformance with Visual Resource Designations in Sections 4.9.2, 4.9.3, 4.9.4, and 4.9.5 analyzes the withdrawal area landscape, including backcountry areas mentioned in the comment, based on Forest Service and BLM visual objectives in their respective land use plans. The Visual Resource Management (VRM) allocations and objectives in the Arizona Strip RMP accounts for sensitive backcountry visual settings in the VRM classifications. For example, all Wilderness and other backcountry areas are classified as Class I, the most sensitive and restrictive visual designation. VRM Class II, the next level of sensitivity and protection, includes other backcountry areas, including all ACECs. Forest Service lands designated SMS Moderate and High in Forest Plans include National Forest backcountry areas within the withdrawal area. All future mining operations will undergo site-specific NEPA analysis to determine visual impact and must conform to land use plan decisions. See the Recreation Sections 3.14 and 4.14 for more detailed information on impacts to

Table 5.6-4. Response to Comments (Continued)

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				backcountry recreation users.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	44	Future Conditions Must be Considered. The DEIS assumes that dense ponderosa pine forests will mask visual intrusions in the North and South Parcels. Vegetation thinning, as part of the Four Forests Restoration Initiative on the South Parcel, or as part of individual ecological restoration projects on the North Parcel, will greatly increase visibility through ponderosa pine forest. Also, fires can open large swaths of land, and fire occurrence can increase when there is increased vehicle access through road building or social trails.	Although sight distances will increase as a result of forest thinning, it is not expected to alter the analysis in the Visual Resources section. Wildfires may result in making cultural modifications more visible within the burn area for some duration after the fire; however, the locations and burning intensity of future fire events is not reasonably foreseeable and thus are not considered in the Visual Resources analysis. There is no evidence that development to support mining activity in this region has had any effect on fire occurrence.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	45	Absent a withdrawal under Alternative B, protection of visual resources is left to BLM and USFS visual resource management systems (Visual Resource Management, Scenery Management System, and Visual Management System) and this permits the impairment of national park, national monument, and wilderness area viewsheds. Potentials for impairment include: East Parcel: The viewshed from Vermilion Cliffs National Monument includes most or all of the East Parcel. The East Parcel has no tall vegetation or topographic features capable of masking mine operations, exploration activities, roads, or power lines. Alternatives C and D may encourage highly concentrated exploration in a smaller area, and will not prevent mine development. Roads and power lines associated with exploration and mine development will be visible under these alternatives, impairing the viewshed of Vermilion Cliffs National Monument, Paria Canyon-Vermilion Cliffs Wilderness, and Saddle Mountain Wilderness. Highway 89A north of the East Parcel is a popular travel corridor that is an integral part of the visitor experience for many tourists. It provides access to the North Rim of Grand Canyon National Park and other regional national parks and monuments, as well as the Lees Ferry river access, wilderness areas, popular hiking trails, hunting areas, and local businesses. Any mines would alter the existing character, be highly visible, and would not meet Class II objectives. Much of the East Parcel is visible from the House Rock Valley Overlook on Highway 89A (Fig. 3.9-2) and from Point Imperial within Grand Canyon National Park (Fig. 4.9-6). Alternative D leaves an area open to exploration and mining that is considered visually valuable (Fig. 2.4-6). South Parcel: Some areas on the South Parcel rated as "Low" are adjacent to the SR 64 through Grand Canyon National Park, and will be visible from the road and/or Grandview Point (Figs. 3.9-3, 4.9-4). Other "Low" areas are visible from several Key Observation Points in Grand Canyon National Park (Figs. 3.9-3, 4.9-1, 4.9-3, 4.9-4, 4.9-5, 4.9-6). Night lighting impacts are possible at all Grand Canyon National Park Key Observation Points (Table 4.9-4). Alternatives C and D may encourage highly concentrated exploration in a smaller area,	Visual resources are managed by both the Forest Service and BLM to protect visually sensitive areas as identified through land use planning. The analysis in the EIS assumes that these agencies will continue to manage visual resources under their regulatory framework. A range of alternatives were analyzed and Alternatives C and D leave portions of the landscape out of the withdrawn lands. The analysis described in EIS section 4.9 does indicate that visual impacts will vary depending on alternative.

Table 5.6-4. Response to Comments (Continued)

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			and will not prevent mine development. Alternatives C and D both leave areas open to exploration and mining that are considered visually valuable (Figs. 2.4-4, 2.4-7). North Parcel: Portions of the North Parcel are visible from Sowats Point (Fig. 4.9-1). More of this parcel is likely to be visible from high points in Grand Canyon-Parashant National Monument, including Mt. Logan Wilderness and Mt. Trumbull Wilderness. Linear features such as roads and power lines will alter the form, line, color, and texture of ponderosa pine forests; dust will decrease the visibility on roads. There is a high probability of mines in Class II areas, in "high use and visually sensitive areas [where they] could be difficult to mitigate to meet the Class II objectives" (p. 4-166). Alternatives C and D may encourage highly concentrated exploration in a smaller area, and will not prevent mine development. Alternatives C and D both leave areas open to exploration and mining that are considered visually valuable (Figs. 2.4-2 and 2.4-5).	
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	55	Visual impacts from exploration and mine operations will also harm Wilderness Areas. In remote Wilderness Areas with truly dark skies, such as the five that are proximal to the Withdrawal Area, isolated lights on mine structures will draw visitors' attention, ruining the untrammeled and undeveloped character of the landscape. As mentioned under the Visual Resources section of these comments, elevated topographic features within Wilderness such as cliff faces and hills enable views far across the landscape. Linear features such as roads and power lines are difficult to mask and will damage the wilderness character of designated and proposed wilderness areas.	Although viewers in Wilderness Areas from high overlooks can see long distances, it is not within the purview of either the BLM or Forest Service to manage those views strictly for the benefit of the wilderness user. Cultural modifications on these broad landscapes are not a part of the wilderness characteristics within designated or proposed wilderness. The effects of the night lights at mines are discussed in EIS Section 4.9. Impacts to the visual resources of any particular feature would be analyzed in the site-specific environmental analysis required for authorizing a mine Plan of Operation.
Quaterra Alaska Inc.	225288	11	The Perrin Ranch wind farm north of Williams AZ will be within full sight of route 64, the major route to the South Rim. It will consist of 62 wind generators which will be 480 feet high at the tip of the windmill blades. The blades will be moving and will presumably be white, which will enhance their visibility. It would be interesting to compare this to a single mine headframe 90 feet high which will be stationary and painted a color to blend in with the landscape, and would be a considerable distance from route 64. It would also be interesting to compare the noise of the windmill blades with the noise of a mining operation.	Although the development of a wind generation facility may have a greater visual effect than a single mine headframe, the purpose of this EIS is not to compare one development with another, but to estimate the impacts of the Proposed Action and Alternatives for this EIS. The estimates of impacts to Visual Resources can be found in Sections 4.9.2, 4.9.3, 4.9.4, and 4.9.5 of the EIS.
The NAU Project, LLC	242913	94	Page 166 *Typically, on-site evaluations and visual contrast ratings would be required prior to any mine development in Class II areas to determine appropriate mitigation measures.* ......However, mining operation visual impacts (described in Section 4.9.2) in high use and visually sensitive areas could be difficult to mitigate to meet the Class II objectives. Do you have any ideas for mitigating measures that might overcome these difficulties?	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as

Table 5.6-4. Response to Comments (Continued)

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				part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
The NAU Project, LLC	242913	95	South Parcel One mine is projected for the South Parcel under Alternative B. This mine is expected to be located in the existing Canyon Mine area, which is designated SMS Moderate. With applicable visual mitigation, this mine can conform to the SMS Moderate visual objectives. This likely conformance would result in minor impacts to visual resources. What might these mitigating measures be?	The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring, that could potentially be considered, as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Water Resources				
Rita Jay	18056	2	Recent studies released by the US Geological Survey show elevated uranium levels in wells, springs and soil in and around Uranium exploration and mining sites within the water shed feeding the Grand Canyon and Colorado River.	The USGS data were incorporated into the EIS, and used to characterize the existing environmental conditions in Sections 3.4 and 3.5, and in some cases to project impacts in Sections 4.4 and 4.5.
Mark Losleben	22060	1	Water-borne pathogens have great and as yet not fully understood health ramifications, human and ecological, and thus should certainly not be allowed into public lands, much less gems such as the Grand Canyon and the Colorado River. (Are pathogens covered in the DEIS?)	Water borne pathogens are not covered in the EIS because they are not considered to be a concern for environmental impact from breccia pipe uranium mines. The only potential source of pathogens from these mines would be the onsite septic systems regulated by ADEQ and the counties to protect water resources pursuant to Aquifer Protection Permits; the septic systems would not be expected to represent a threat to water resources.
Robert E. Grossman	54251	4	The DEIS mentions water to control dust. What is the estimate for such water use and what is the source of such water?	Section B.8.1 of FEIS Appendix B, it is estimated that the average rate of water use to suppress dust at each mine site is 3 gpm for an average 4-year mine life span. Source of the water is mine drainage collected in the mine sump and, when necessary, groundwater from deep R-aquifer water supply wells.
Kaibab Band of Paiute Indians	246166	4	As the composition of the subsurface geology is apparently unknown, assurances that aquifers will be protected are baseless. This site-specific characterization of groundwater must be completed before any conclusions can be reached.	Uncertainty in available water resources information is addressed in the EIS in Section 4.4.2. Although uncertainty is in some cases substantial and cannot be eliminated, the use of conservative assumptions allows meaningful, though not precise, assessments of potential for impacts to occur. Incomplete and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				unavailable information adds to uncertainty of analyses. This uncertainty cannot be readily quantified; however, where possible and appropriate, uncertainties have been addressed by the use of best available information and conservative assumptions when projecting potential impacts. Therefore, reasonable assessments were made to provide the decision-maker with an adequate basis for weighing the relative potential for impacts to water resources from each alternative. It should be emphasized that detailed, site-specific environmental analysis would be required for any new mines in the proposed withdrawal area and that the data necessary to assess the potential impacts on a case-by-case basis would be obtained and evaluated at that time. Site-specific characterizations are not feasible or appropriate for this EIS, which analyzes the effect of the proposed withdrawal on projected potential resource impacts.
American Whitewater	54357	3	Your analysis seeks to quantify the risks of allowing uranium mining near the Grand Canyon. The results of your analysis confirm that the risks of long term water quality and quantity impacts exist that could impact iconic tributaries to the Grand Canyon. We believe that by excluding the Grand Canyon paddling experience from your analysis, including hiking along, swimming in, and drinking from the tributaries, you have miscalculated the risks of allowing future uranium mining. Radiation and other pollution in these streams would directly impact human health and perceptions of wildness. Even very small reductions in flow in tributaries and springs would impact the experience of these places.	Potential water quality impacts to R-aquifer springs, which feed perennial streams flowing in the Grand Canyon, are discussed in EIS Section 4.4.4 (Subsection R-aquifer Springs Quality) and summarized in Table 4.4-5. With the exception of small South Rim springs, which do not typically support significant stream flow, potential concentrations of arsenic and uranium are projected to range from ambient levels to below EPA MCLs. Therefore, assuming a few days of water consumption or exposure at spring-fed streams by Colorado River paddlers would represent a negligible risk to human health. Please see EIS Section 4.4.1 (Subsections Chemical Quality of Regional R-Aquifer Springs and Wells – Springs) for discussion of EPA MCLs. Potential water quantity impacts to R-aquifer springs, which feed perennial streams flowing in the Grand Canyon are discussed in EIS Section 4.4.4 (Subsection R-aquifer Springs Quantity). With the exception of small South Rim springs, which do not typically support significant stream flow, potential impacts on spring flow are projected to be less than 5% of the total flow, which is less than typical measurement accuracy. This small level of change in

Table 5.6-4. Response to Comments (Continued)

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				stream flow would not likely be perceptible to the casual observer or discernible beyond typical seasonal variations.
Don Lipmanson	96015	1	I know from the posted warning signs that groundwater at Salt Creek cannot be consumed on account of radioactivity from former mining. Likewise, uranium mining in national forests nearby Grand Canyon NP could seriously threaten air safety in the region.	Concentrations of uranium detected in water samples obtained from Salt Creek range from about 29 to 31 ug/L (see EIS Appendix F, Table F-1, Project Site ID 393), which is near the EPA drinking water maximum contaminant level (MCL) of 30 ug/L. Elevated uranium concentrations in groundwater and surface water along this section of the South Rim of Grand Canyon may be associated with natural sources. No mines are located in the Salt Creek surface water drainage basin.
Greg Webb	103019	2	The hydrology section of the report is based, in many cases, on conceptual models of how water movement occurs throughout this region. The report is full of language that uses words like 'expected', 'likely', and 'may' to describe water movements, impacts, etc. It is clear, then, that the hydrology of this region is not clearly understood, and it is threfore alarming that you are able to claim that Alternatives C and D, and even A, ae likely to have little impact from uranium mining in regards to water quality.	Uncertainty is addressed in the EIS in Section 4.4.2. Although uncertainty is in some cases substantial and cannot be eliminated, the use of conservative assumptions allows meaningful, though not precise, assessments of potential for impacts to occur. Incomplete and unavailable information adds to uncertainty of analyses. This uncertainty cannot be readily quantified; however, where possible and appropriate, uncertainties have been addressed by the use of best available information and conservative assumptions when projecting potential impacts. Therefore, reasonable assessments were made to provide the decision-maker with an adequate basis for weighing the relative potential for impacts to water resources from each alternative. It should be emphasized that detailed, site-specific environmental analysis would be required for any new mines in the proposed withdrawal area and that the data necessary to assess the potential impacts on a case by case basis would be obtained and evaluated at that time.
Cynthia Pando	104125	1	Please improve the DEIS by doing a more extensive study on the impact in the ground water, aquifer, and watersheds. The DEIS does not seem to corroborate or use sources that have shown significant and different impact datat on groun water, aquifer , and watersheds from sources such as Dr. Abe Springer, Dr. Ingram and others at NAU.	The DEIS uses the best available science in its formulation. The DEIS represents an exhaustive compilation of available data for these resources and, to our knowledge, does not omit any significant data sources. Dr. Springer was consulted regarding data sources that might be included or considered in the analysis. Work by Drs. Springer and Ingram was evaluated and used in the USGS SIR 2010-5025, which is a frequently cited reference in the DEIS.
	104132	1	Please be advise that there has not been enough research and examination documented that can prove that uranium mining will not affect	Incomplete or unavailable information and the resulting uncertainty are discussed in EIS Section 4.4.2 for

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			not only the air but also the groundwaters and aquifers that flow throughout the area within Grand Canyon.	water resources. The effect of data uncertainty on impact assessments is addressed throughout the discussion of impacts to surface and groundwater resources in EIS Section 4.4.4.
Rich Csenge	221984	3	A final question is this: Has consideration been given during the EIS to what degree a reduction in the flow of water in Kanab Creek resulting from the Jackson Flat Reservoir, currently being constructed in Kanab to impound the flow of Kanab Creek.	Jackson Flat Reservoir does not impound the flow of Kanab Creek; it is an off-stream storage reservoir supplied by an existing diversion dam and irrigation piping system. The FEIS has been revised to include discussion of Jackson Flat Reservoir in the cumulative analysis section for water resources (Section 4.4.4, Subsection Cumulative Impacts).
Donna Brown	225253	6	With climate change, there are projections of even more violent or unpredictable storm events that could make these retention ponds more vulnerable.	Design of the mine water retention/evaporation ponds is reviewed and approved by the BLM, Forest Service, and the ADEQ on a case-by case, site-specific basis. If hydrologic data indicate that potential flood flows at these mines are increasing, these agencies have the authority to upgrade pond designs to prevent breaching.
Donald Begalke	225254	13	Do "uranium dust" and micro-particles satisfy uranium's affects on all lives within the greater Grand Canyon country area, and affects on human water consumptions plus agricultural uses both downstream Colorado River uses, fed by drainages, seeps and tributaries from the uranium-mines' areas in the Grand Canyon country area?	The EIS addresses water quality issues in Sections 3.4 and 4.4 and soil contamination in Sections 3.5 and 4.5.
Donald Begalke	225254	14	Since this withdrawal proposal was announced in July 2009, did the BLM study all such contributing waters using safe dyes, thus including such reports in this Draft?	Due to long residence times, difficult identification of appropriate dye entry and exit points, and the limited duration of this EIS analysis, and other reasons, dye testing was not a feasible option for the scope of this EIS. The EIS relied on the best available science, including USGS SIR 2010-5025.
Donald Begalke	225254	15	Since thousands of new uranium mining claims were filed, what would the total "mgal" be for all those mines, and how would such a very, very great volume of waters used for mines' operations change the greater Grand Canyon country area and all types of lives residing there, and considerations for businesses plus other operations in the greater area must be included? The answers should have been in this Draft, but are not, and should be in the Final EIS for this withdrawal project.	Only a small fraction of the mining claims would eventually become operating mines. The projected number of mines that might go into operation under each alternative during the next 20 years is given in EIS Appendix B (Table B-43). This table also gives the projected water usage. Potential impacts from this water usage are discussed in EIS Chapter 4 Section 4.4.4 (Subsections R-aquifer Springs Quantity, and R-aquifer Wells Quantity).
American Clean Energy Resources Trust (ACERT)	225256	13 & 14	WATER RESOURCES Page ES-12 Statement: *Resource condition indicators for water resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the quantity and quality of water discharge at springs that issue*	Although there are numerous studies cited and interpretive statements made in the EIS that indicate potential impacts to water resources may be none or negligible, there are other instances where the lack of

Table 5.6-4. Response to Comments (Continued)

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			*from perched groundwater zones that may be affected by operations at nearby mine sites, quantity and quality of water discharge at springs that issue from the regional R-aquifer system that may be depleted by operations at mine sites, and the quantity and chemical quality of receiving surface waters.*Comment: While numerous studies, some cited in Chapter 3, indicate that there is little evidence of higher values of uranium in the water caused by uranium mining and exploration, the study persists with the subjective, biased assumption that any activity will have a negative impact on the study areas. The following statements from the DEIS point to the low probability of water contamination from uranium mining and exploration: *Page 3-57 breccia pipe uranium mine sites in the study area are generally characterized by wellcemented, very low permeability breccias and adjacent formation rocks, which do not permit the flow of groundwater through the tightly locked mineral deposits. This condition inhibits dissolution of mineral deposits associated with these economically viable breccia pipes into groundwater. Some ring fracture zones and the cemented breccia itself at these sites have locally contained some connate water (water trapped during formation of the geological feature), which drained away quickly when intercepted by mine openings; at many places, the ring fracture zones had been completely healed by carbonate or other mineralization and did not yield water . Conditions are not favorable for downward migration of leached minerals and constituents (such as uranium and arsenic) from the ore deposits to the R-aquifer . AAC R12-15-817 for exploration wells and AAC R12-15-816 for water wells require proper abandonment to prevent cross-contamination of different aquifers.(2 of 2) attached to previous comment Page 3-58 None of the studies conducted for water quality at these wells, one of which included periodic sampling data for up to 9 years after completion of mining activities (Hermit well), concluded that uranium mining activities have affected the R-aquifer. Based on their 2009 water quality sampling study, which included sampling of the Pinenut and Canyon mine wells, Bills et al. (2010) concluded that relations between the occurrence of dissolved uranium and 13 other trace elements and mining activities were few and inconclusive. Page 3-58-59 Movement of perched water away from the mine openings is not anticipated to occur during mine operations. Page 3-69 These perched reservoirs are commonly small, thin, and discontinuous, and generally depend on annual recharge to sustain yield to wells and springs (Bills et al. 2010; Montgomery et al. 2000). The perched aquifers overlie and have no direct hydraulic connection to the deep R-aquifer; therefore, any downward movement of perched groundwater is by gravity drainage Page 3-75 (north parcel).*	sufficient data and associated uncertainty require conservative assumptions to be made to project impacts (see Table 4.4-3). Some of those potential impacts range up to moderate to major even though the probability of such impacts might be low or unknown.
			Continued...Therefore, exploration and development activities in the North Parcel can not affect the springs that are supported by recharge and groundwater movement in the Kaibab Plateau. Page 3-77 The cause of the decrease was not identified and could be the result of a complex set of	

Table 5.6-4. Response to Comments (Continued)

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			circumstances, including decreasing preCipitation trends and pumping from the aquifer at Tusayan since 1989. This decrease is not attributed to uranium mining operations because there have been no uranium mining or groundwater withdrawals from the R-aquifer for mining in the South Parcel or adjacent areas during the period of the Rihs et al. (2004) study, and only minor use of the Canyon Mine well since it was drilled. Page 3-79 A principal conclusion of the 2010 USGS report was that "observation of groundwaterchemistry relations between concentration and mining condition (no exploration or development activity, active mines on interim management, or reclaimed mine areas) were limited and inconclusive" (Bills et al. 2010:194). Page 3-85 Dissolved uranium concentrations exceeding the regional average of about 7 ~g/L detected in groundwater or springs near existing and/or former mines do not necessarily indicate that the water is impacted from exploration and development activities.	
American Clean Energy Resources Trust (ACERT)	225256	22	Page 2.33, Table 2.8-1: Perched Aquifer Wells Comment: North Parcel: With Alternative A. impacts could vary from no mines located where they may affect wells to as many as 11 . With Alternative B. impacts could vary from no mines located where they may affect wells to 1. East Parcel: With Alternative A. impacts could vary from no mines located where they may affect wells to as many as 5. With Alternative B. no mines are located where they may affect wells. South Parcel: With Alternative A. impacts could vary from no mines located where they may affect wells to as many as 4. With Alternative B. impacts could vary from no mines located where they may affect wells to 1. Comment: Does a comparison of these numbers of wells justify the removal of 1 + million acres of land from mining, since each site would be subject to rigorous scrutiny with a separate EIS? Page 2-34. Table 2.8-1 : Deep Aquifer Springs, Quantity Comment: North Parcel: Under Alternative A, the volume of water withdrawn from the mine-related Raquifer wells would be between 0% and 5%, over a 20-year period. This is based on 21 mines using 21 gpm which is 4.5% of the 470 gpm discharge from the Kanab and Showerbath springs. This amount of water from the springs is uncertain. Since the reach of these springs is diffuse. the reach is probably considerably larger. So the potential impact is likely negligible. Under Alternative B, the volume of water withdrawn from the mine-related R-aquifer wells would be between 0% and 5%, over a 20-year period. In this case, 10 mines would use 10gpm. Again, the impact is negligible East Parcel: Alternative A the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period.	The citations from Table 2.8-1 made in this comment are confused. The remainder of the comment appears to re-express the results given in Table 2.8-1 into the relative impact categories defined in Table 4.4-1 and assigned for each parcel and alternative in Table 4.4-3. The range of spring flow impact defined for a negligible impact on R-aquifer springs (between 0% and 5%) is reasonable and is based on the minimum probable uncertainty in typical stream flow measurements reported by Harmel et al. (2006), as discussed in Section 4.4.1 (Discharge from Regional R-aquifer Springs and Wells). For the FEIS, actual calculated percentages are included in Table 2.8-1 together with the generic range for the category.
			Continued...This is an overestimate since the water flow into the Colorado River from the South Canyon walls is about 3,700 gpm, but there is flow from the other side and into the river from the R-aquifer directly. So the decrease is 0.1% or negligible. Under Alternative B, the volume of water	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			withdrawn from the mine-related R-aquifer wells downgradient from the mine would be 0%, over a 20-year period. South Parcel: Havasu and Blue Springs Under Alternative A, the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This is a high estimate since the 7 projected mines will draw 7 gpm over the 20-year period. The Havasu Springs have a flow of 29,000 gpm and the Blue Springs complex flow is 46,000 gpm. Hence, the impact is negligible for either of the springs. Havasu Springs only In Table 2.8-1, under Alternative B the volume of water withdrawn from the mine-related Raquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This range is unrealistically large, since the backup discussion indicates that the one mine that might impact the Havasu Springs would result in a decrease of 0.01 % and would not even be measureable. South Rim Springs In Table 2.8-1, under Alternative A the volume of water withdrawn from the mine-related Raquifer wells downgradient from the mine would be between 0% to more than 10%, over a 20- year period. If the mines were located in the basins of the Hermit Springs or the Garden Springs, the flow from each is around 300 gpm, so the decrease in discharge would be less than 2%, which is negligible Other Springs Under Alternative B, the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be 0%, over a 20-year period. The summary table presents exaggerated ranges for the impacts under Alternative A. This is liable to mislead a number of readers	
American Clean Energy Resources Trust (ACERT)	225256	27	Pages 3·57 to 3-60 Comment: There is a good discussion of the mining legacy in the Arizona Strip in Section 3.4.4. 1. It should be noted that Figure 3.4-5 shows 207 breccia pipes that are exposed and lie mostly within the Grand Canyon itself. These are being continually eroded and if any of these are mineralized they are contributing dissolved uranium, arsenic, and other metals to the Colorado River. These have nothing to do with new uranium mining. 2. The discussion in the DEIS restricts itself to the mining legacy within the study area. This shows little detriment to the environment or tourism. However, when the tribes and many environmental groups talk about the legacy of uranium mining they refer to the mines that were operated during and immediately after World War II. This is what led to the Dine Natural Resources Protection Act (DNRPA) of 2005. Therefore, some mention of this in the DEIS appears appropriate	1. The FEIS contains an expanded discussion of the range of potential hydrogeologic conditions at breccia pipes in Section 3.4.4, including breccia pipes that are exposed. 2. The Dine Natural Resources Protection Act (DNRPA) of 2005 is law enacted by the Navajo Nation that bans uranium mining, milling, and processing on tribal lands. Because this law and the concerns that may have led to its passage do not apply to the withdrawal area, it is not appropriate to discuss it in the EIS.
American Clean Energy Resources Trust (ACERT)	225256	29	Statement: *Natural processes and human activities (including improperly abandoned mines and improperly disposed mine waste or waste rock) can cause concentrations of dissolved trace elements and radionuclides to be elevated in groundwater and surface water.* Comment: Not since the '50's, have there been "improperly abandoned mines and improperly disposed mine waste or waste rock". With the plethora of agencies and regulations controlling every aspect of exploration, mining and reclamation, along with	The cited text is in EIS Section 3.4.7. The DEIS statement is true as written and does not imply what has actually occurred in the past or what will happen in the future. The EIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			penalties for non-compliance, abandoned mineslwaste are not an issue.	the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable Development Scenarios, Section B.3, Regulatory Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
American Clean Energy Resources Trust (ACERT)	225256	30	Statement: *Results for water quality analyses were compiled from the sources noted above for a total of 687 sampling locations in the water resources study area and for 6- mile buffers around each of the parcels.* Comment: One million acres is not enough of a "buffer zone" without adding another 6 miles around each parcel?? What is the reason for that?	These “buffers” were used only to aid in characterization of the Water Resources Study area and are not part of the proposed withdrawal area. The FEIS provides additional clarification on these “buffers” in Section 3.4.7.
American Clean Energy Resources Trust (ACERT)	225256	31	Pages 3-82 through 3-84: Figures 3.4-16a, 3.4 - 16b, 3.4 - 16c Comment: These maps do not include the location of breccia pipes that outcrop within the Grand Canyon National Park that may be near the location of samples which have been chemically analyzed. But they do include the location of the mines. This gives the reader the impression that all of the elevated values are caused by the mining and not by proximity to mineralized breccias pipes that nature has exposed in the surrounding canyons. Of particular interest is the sample location in Tuckup Canyon. This sample site is adjacent to a known pipe that has elevated radioactivity at outcrop.	The breccia pipe dataset has been added to the figures suggested in the FEIS.
American Clean Energy Resources Trust (ACERT)	225256	32	Pages 3-85 Statement: *Dissolved uranium concentrations exceeding the regional average of about 7 ... µg/L detected in groundwater or springs near existing and/or former mines do not necessarily indicate that the water is impacted from exploration and development activities. In hydrologic systems poorly connected to the regional groundwater circulation system in the R-aquifer, it is unlikely that discharge to springs is substantially mixed with groundwater from distant sources. The isotopic composition of uranium in water from such systems may be used to evaluate whether high uranium concentrations result from the natural dissolution of uranium-bearing rocks or from anthropogenic activities at uranium mines (Appendix G). Samples exhibiting high 234U activity relative to 238U activity are indicative of ambient groundwater because of the preferential mobility of 234U in natural waters. Conversely, samples having 234U activity approximately equal to 238U activity represent conditions of aggressive water-to-rock interaction symptomatic of water impacted by mine leachate. Isotopic and dissolved uranium data compiled for the study area and Colorado River indicate that only samples collected from Horn Creek springs, which originate from the R-aquifer about 1/2 mile or less north of the Orphan Lode Mine, have high concentrations of dissolved uranium (>30 pg/L) and an 234U/238U activity ratio near one. Apparently, surface water and/or perched groundwater seepage into the abandoned, unreclaimed mine workings of the Orphan Lode Mine have interacted with mine waste andlor disturbed ore deposits to generate*	The fact that the Orphan Lode Mine is a singularly poor example of post-mining practices is acknowledged in EIS Section 3.4.4. In addition, the fact that none of the R-aquifer studies regarding long-term monitoring at deep mine wells have concluded that uranium mining activities have affected the R-aquifer is acknowledged in Section 3.4.4. However, data for the Orphan Lode Mine provide the best available information on concentrations of uranium in mine drainage that is believed to have migrated to the R-aquifer and discharged at a nearby spring, as well as the only data in the Grand Canyon region exhibiting anthropogenic characteristics (as described in EIS Section 3.4.7 (Subsection Legacy Impacts to Water from Uranium Mining) and Appendix H). Please refer to FEIS Section 4.4.1 (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells, Springs) for discussion of assumptions used to project potential impacts. This section describes the range of reasonably foreseeable impacts, not worst-case impacts.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			elevated concentrations of uranium in water that has moved vertically downward from the mine openings into the R-aquifer. Additional monitoring data are necessary to rule out the possibility that groundwater in locations other than Horn Creek springs may also be impacted from uranium mining because potential mixing of impacted water with native groundwater may mask the isotopic signature. Comment : Why the emphasis on Orphan Mine - it pre-dates current modern mining practices and is outside the study area (and according to some knowledgeable resources, the water quality study is of questionable value). It may be more accurate to define the "legacy" as minimum impact to water resources with reclaimed sites indistinguishable from their surroundings - the "legacy" of the exploration and mining of the 70's, 80's and 90's.	
American Clean Energy Resources Trust (ACERT)	225256	33	Page 3-85: Orphan Mine and Horn Spring Comment: The EIS says that Horn Spring contains elevated uranium levels because of mining at the Orphan Mine. There is no data to conclusively prove this. It is possible that the elevated uranium levels of Horn Spring are because of mining at the Orphan mine, however there are other equally likely reasons. The elevated uranium could be because of the natural uranium mineralization, either at the Orphan Mine or in other undisturbed mineralized pipes in the area. The high U-234/U-238 ratio could be because of solution by acid produced through natural oxidation of pyrite associated with uranium mineralization independent of mining. Unless solutions migrated along faults or fractures, not nearly enough time has elapsed since mining at the Orphan Mine for solutions to have percolated through the Hermit and Supai beds to the Redwall karst and subsequently to Horn Spring. If the Orphan Mine is proven to be the source of elevated uranium levels in Horn Spring, and if some government agency comes up with a reason to shut off the source of the elevated uranium, reclamation should be the Park Service's responsibility. The Park Service acquired title to the mine in 1963, and mining ceased in 1969. In the 41 years since then the mine has set unreclaimed except for some relatively minor cosmetic reclamation above the canyon rim within the last 2-3 years. In the 1980's Energy Fuels offered to reclaim the mine using their expertise, engineers, miners, and equipment at no charge as a public service. The Park Service refused the offer. It needs to be mentioned in the EIS that the Park Service is the owner of the Orphan Mine, and has been even for the last several years of mining. so that the public knows that it is the Park Service and not a private mining company which has let the Orphan Mine go unreclaimed for 41 years. Energy Fuels' offer to reclaim the mine, and the Park Service's refusal also needs to be mentioned in the EIS.	Although there may be other potential sources of uranium in the area of the Orphan Lode Mine, the combined occurrence of elevated uranium concentrations and an isotopic activity ratio of $^{234}U/^{238}U$ near 1 in the samples from Horn Creek springs is strongly indicative of an anthropogenic source, not a source from natural erosion (see Figures H-1 and H-2 in EIS Appendix H). The amount of surface area exposed to migrating waters is likely insufficient under natural conditions to generate both an elevated uranium concentration and an isotopic activity ratio of 234U/238U near 1, as is associated with disturbance by mining. If the opposite were true, there should be more evidence than this single instance in the Grand Canyon region of elevated uranium concentration coupled with an activity ratio near 1, but there is none (see Table H-1 in EIS Appendix H). In addition, the Liebe (2003) water samples were collected directly from the spring at the base of the Redwall-Muav limestone contact directly downslope from the Orphan Lode Mine workings. Therefore, other explanations for the sampling results are not as likely as the interpretation given in the EIS. As discussed in EIS Section 3.4.4, the location of the Orphan Lode Mine at the canyon rim increases the risk of mine drainage via enhanced secondary permeability of faults or flexure fractures; therefore, the fracture pathway alluded to in the comment could very well have decreased travel time for mine drainage to the R-aquifer.
American Clean Energy Resources Trust	225256	69	Page 4-68 Comment: North Parcel: With Alternative A the probability of impact is 13.2% (moderate). The range of values generally indicates more than an 80% probability that any spring would not be impacted. With	Table 4.4-3 describes the potential impacts to perched aquifer springs quantity and quality. The methodology for deriving these impacts is described in Section 4.4.1

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
(ACERT)			Alternative B the probability of impact is 5.4% (moderate). The range of values generally indicates more than an 80% probability that any spring would not be impacted. East Parcel: With Alternative A the probability of impact is 1.3% (negligible). The range of values generally indicates more than a 95% probability that any spring would not be impacted. With Alternative B the probability of impact is 0%. Since there would be no new mines there will be no impact. South Parcel: With Alternative A the probability of impact is 0.2% (negligible). The range of values generally indicates more than a 95% probability that any spring would not be impacted. With Alternative B the probability of impact is 0.2%. Only the Canyon Mine will be developed. As explained in the text all the probabilities are overestimated (Section 4.4.1, page 52). This tends to bias the data in favor of Alternative B compared to Alternative A. Even with this predisposition, does a comparison of these probabilities justify the removal of 1 + million acres of land from mining, based on this factor?	(Quantity of Discharge from Perched Aquifer Springs and Wells – Springs). The calculation is applied equally for each alternative and is designed to provide a consistent method to compare alternatives. It is not intended to be predictive, but to capture uncertainty.
American Clean Energy Resources Trust (ACERT)	225256	70	Pages 4-71 to 4-74 Comment: North Parcel: Under Alternative A the volume of water withdrawn from the mine-related Raquifer wells would be between 0% and 5%, over a 20-year period. This is based on 21 mines using 21 gpm which is 4.5% of the 470 gpm discharge from the Kanab and Showerbath springs. This amount of water from the springs is uncertain. Since the reach of these springs is diffuse, the reach is probably considerably larger. So the potential impact is likely negligible. Under Alternative B the volume of water withdrawn from the mine-related R-aquifer wells would be between 0% and 5%, over a 20-year period. In this case 10 mines would use 10gpm. Again, the impact is negligible. East Parcel: Alternative A the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This is an overestimate since the water flow into the Colorado River from the South Canyon walls is about 3,700 gpm, but there is flow from the other side and into the river from the R-aquifer directly. So the decrease is 0.1 % or negligible Under Alternative B the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be 0%, over a 20-year period. South Parcel: Havasu and Blue Springs Under Alternative A the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This is a high estimate since the 7 projected mines will draw 7 gpm over the 20-year period. The Havasu Springs have a flow of 29,000 gpm and the Blue Springs complex flow is 46,000 gpm. Hence the impact is negligible for either of the springs. Havasu Springs only In Table 2.8-1, under Alternative B the volume of water withdrawn from the mine-related Raquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This range is unrealistically large, since the backup discussion indicates that the one mine that might impact the Havasu Springs would result in a decrease of 0.01% and would not even be measureable. South	Table 2.8-1 has been revised in FEIS to include actual calculated percentages together with the generic range for the category.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Rim Springs In Table 2.8-1, under Alternative A the volume of water withdrawn from the mine-related Raquifer wells downgradient from the mine would be between 0% to more than 10%, over a 20- year period. If the mines were located in the basins of the Hermit Springs or the Garden Springs, the flow from each is around 300 gpm, so the decrease in discharge would be less than 2%, which is negligible Other Springs Under Alternative B the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be 0%, over a 20-year period. The summary table presents exaggerated ranges for the impacts under Alternative A. This is liable to mislead a number of readers. In all cases the impacts are negligible; this should be clarified.	
American Clean Energy Resources Trust (ACERT)	225256	71 & 72	Page 4-75 Comment: North Parcel: The following assumptions were made for this assessment: 1. Zero to half of the 21 mines (11 mines) predicted for the North Parcel are assumed to contribute 1 gpm of water containing 400µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest Raquifer springs undiminished (Kanab and Showerbath springs). 2. The average ambient concentration of dissolved uranium in the aggregate discharge (470 gpm) from these springs is 4.9µg/L and the concentration of dissolved arsenic is about 2µg/L (see Table 4.4-5). Under Alternative A at least one mine might contribute impacted water to the R-aquifer; uranium and arsenic might exceed ambient levels but not drinking water standards. These results are obtained on the assumption that 11 mines "contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs). This would raise the projected concentrations from 4.9µg/L to 11µg/L for uranium and 2µg/L to 3µg/L or arsenic. The lower figures in each range are the ambient concentrations. 1. The assumptions do not seem realistic. Unless the mine was located next to Kanab or Showerbath springs, there would be considerable dilution due to distance and flow path, geochemical character of the groundwater, residence time of the solution in the aquifer, and other factors. The R-aquifer is very large, so dilution would be 2. It should be noted that the impacts under both altematives range from none to moderate. 3. Each mine would have to undergo rigorous scrutiny for a site-specific EIS. Page 4-75 Comment: Under Alternative A at least one mine might contribute impacted water to the Raquifer; uranium and arsenic might exceed ambient levels but not drinking water standards. These results are obtained on the assumption that 11 mines "contribute 1 gpm of water containing 400µg/L of dissolved uranium and 90µg/Lof dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs)." This would raise the projected concentrations from 4 . 9µg/L to 11µg/L for	EIS Section 4.4.1 (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells) provides the basis for the assumptions and calculations used to project R-aquifer impacts to water quality. This discussion has been expanded and clarified in the FEIS. As stated in EIS Section 4.4.1, sufficient data are not available for the aquifer system or the potential locations for future mines to adequately characterize all the possible flow paths and dilution/attenuation rates for groundwater movement in the R-aquifer; therefore, conservative assumptions were made in an attempt to account for this uncertainty. The statements made in items 2 and 3 of this comment are addressed in several locations in the EIS (e.g., Table 4.4-3 and Section 4.4.2).

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			uranium and 2µg/L to 3µg/L for arsenic. The lower figures in each range are the ambient concentrations. Under Alternative B at least one mine might contribute impacted water to the R-aquifer; uranium and arsenic might exceed ambient levels but not drinking water standards. These results are obtained on the assumption that 5 mines "contribute 1 gpm of water containing 400µg/L of dissolved uranium and 90µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs)." This would raise the projected concentrations from 4 . 9µg/L to 9µg/L for uranium and 2µg/L to 3µg/L for arsenic. The lower figures in each range are the ambient concentrations. 1. The assumptions do not seem realistic. Unless the mine was located next to Kanab or Showerbath springs, there would be considerable dilution due to distance and flow path, geochemical character of the groundwater, residence time of the solution in the aquifer, and other factors. The R-aquifer is very large, so dilution would be significant. 2. It should be noted that the impacts under both alternatives range from none to moderate. 3. Each mine would have to undergo rigorous scrutiny for an site-specific EIS.	
American Clean Energy Resources Trust (ACERT)	225256	73	Pages 4-75 to 4-78 Comment: East Parcel: Under Alternative A, zero to two mines might contribute impacted water to the Raquifer; uranium and arsenic might exceed ambient levels but not drinking water standards. These results are obtained on the assumption that one mine "contributes 1 gpm of water containing 400µg/L of dissolved uranium and 90µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (west side Fence Fault complex in Marble Canyon)." This would raise the projected concentrations from 1.7µg/L to 1.8µg/L for uranium and remain at 10µg/L for arsenic. The lower figures in each range are the ambient concentrations. Under Alternative B there would be no impact, since there would not be any mines in this parcel. South Parcel: Under Alternative A, for Havasu and Blue springs, zero to one mine might contribute impacted water to the R-aquifer; uranium and arsenic would not exceed ambient levels. These results are obtained on the assumption that four mines "contribute 1 gpm of water containing 400µg/Lof dissolved uranium and 90µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished." The ambient levels for uranium are 6µg/L for Havasu Springs and 7µg/L for Blue Springs. The levels for arsenic are 10µg/L for Havasu and 5µg/L for Blue Springs. These remain unchanged because of the contributions from the mines because of the large flows in these springs. Under Alternative A, for South Rim springs, zero to one mine might contribute impacted water to the R-aquifer; uranium and arsenic may exceed the EPA drinking water standards. For uranium the range might be 4 to 70µg/L and for arsenic it might be 10 to 30µg/L. The EPA MCLs for uranium are 30µg/L and for arsenic 10µg/L. Thus the impact ranges from none to	Please refer to comment 225256-71 (ACERT) for response regarding assumptions for projection of R-aquifer spring impacts. The statements made in items 1, 2 and 3 of this comment are addressed in several locations in the EIS (e.g., Table 4.4-3, Table 4.4-5, and Section 4.4.2).

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			major. For the Hermit Springs the range is between 3 to 4µg/L for uranium and for Garden Springs it is 3 to 5µg/L. The lower values are the ambient levels. For arsenic the ambient level for the Hermit Springs are 10µg/L, which is not impacted. Under Alternative B, for Havasu Springs only, from zero to one mine might contribute impacted water to the R-aquifer; uranium and arsenic may exceed the ambient levels. No mines would impact the other springs. 1. It should be noted that some of the springs are already at the EPA MCL for arsenic 2. The assumption that the waters will reach the springs undiminished is not realistic. The R-aquifer is very large. 3. Each mine would be subject to strict scrutiny under a separate EIS, so either the mine would not be permitted, or adequate corrective steps would be incorporated.	
American Clean Energy Resources Trust (ACERT)	225256	74	Page 4-79 Comment: North Parcel: Under Alternative A Perennial Streams: The decrease in water would vary from negligible if the R-aquifer is the major source to large if these are fed by perched aquifers, which have a probability of 13.2%. Ephemeral Streams: The changes will generally be undetectable, unless the mine in steep topography. Under Alternative B Perennial Streams: The decrease in water would vary from negligible if the R-aquifer is the major source to large if these are fed by perched aquifers, which have a probability of 5.4% Ephemeral Streams: The changes will generally be undetectable, unless the mine in steep topography. East Parcel: Under Alternative A Perennial Streams: If these are fed by perched aquifers, there is a probability of 1.3% of being impacted. Under Alternative B There will be no impact. South Parcel: Under Alternative A Perennial Streams: The decrease in water would be negligible if Havasu or Blue Springs support the stream flow. The impact would vary from 0% to 10% for the smaller South Rim Springs; the probability for which is 0.2%. Ephemeral Streams: The changes will generally be undetectable, unless the mine in steep topography. Under Alternative B Perennial Streams: The decrease in water would be negligible if Havasu, Blue Springs, South Rim springs, or perched water aquifers support the stream flow. Only the Canyon Mine will be developed. Ephemeral Streams: The changes will be undetectable.: 1. Impacts to the Colorado River would be undetectable, because of its large flow (minimum of 1.6 million gpm). Even if all 30 mines operate the change would be 0.002% which is not measurable. 2. There is no basis to withdraw 1+ million acres for surface water reduction reasons.	Potential impacts to the Colorado River are discussed in EIS Section 4.4.4 (Subsection Surface Waters).
American Clean Energy Resources Trust (ACERT)	225256	75	Pages 4-80 to 4-82 Comment: There is little impact to the quality of the surface water, except when the mine is located within the groundwater drainage area of a perched aquifer spring, especially if the spring is small. This applies to Alternatives A and B; only B will have no mines in the East parcel and only the Canyon mine in the South Portal. It appears that the analysis does not consider any dilution from the perched aquifer to the impacted mine water. It should be borne in mind that the mines use only 5	Impacts to perched aquifer quality were not quantified, but were classified as either no impact if a mine would not be located with the groundwater drainage area for the perched aquifer, to major impact if a mine would be located within the drainage area. As described in EIS Sections 3.4.4 and 4.4.1 (Subsections Quantity of Discharge from Perched Aquifer Springs and Wells

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			gpm of water, not all of which necessarily runs off and impacts the aquifer. Some of the water is used to allay the dust in the mine during drilling and comes out of the mine with the ore when it is brought to the surface. This ore is not dried out before shipping to the mill site, but some of the water evaporates into the atmosphere.	and Chemical Quality of Perched Aquifer Springs and Wells), during mining, the perched aquifer adjacent to the breccia pipe will drain toward the pipe and contamination would not be expected to springs that discharge from the perched aquifer, if any. After mining ceases, if the perching layer is not re-established, the mine openings could continue to drain the perched aquifer and might impact the quantity of discharge at springs that rely on the perched aquifer as a source. If the perching layer is re-established, although the quantity impact could be reduced or eliminated, perched groundwater has the potential to move through mine openings above the perching layer where contaminants might mobilize and travel toward the spring. The analysis is based on data for perched aquifers that suggest the volume of perched groundwater available for dilution is generally insufficient to significantly reduce potential contaminant concentrations.
American Clean Energy Resources Trust (ACERT)	225256	76	Pages 4-80 to 4-82 Comment: The probability of a flood breaching a properly designed, constructed, and maintained berm over 20 years is about 4% (footnote page 4-80). So the primary mechanism of contaminant dispersal outside the mine perimeters is fugitive dust. Wind-deposited constituents could impact perennial streams or impounded surface waters by direct deposition. The dispersion of dust from the stored ore could be readily reduced by placing the ore in a covered area. The waste rock does not contain enough uranium to be a major problem (otherwise it would not be waste). Both types of rock are to be placed on concrete pads, as required by APP.	Waste rock materials may not contain enough uranium to warrant processing, but still may contain concentrations of trace elements that exceed concentrations in native soil/sediment/rock in the area, as discussed in EIS Chapter 3 Section 3.5.4 (Subsection Existing Soil Contamination). Thus, fugitive dust does represent a potential impact to surface waters, as discussed in EIS Section 4.4.4 (Subsection Surface Water Quality). Specific mitigation measures will be developed on a case-by-case basis during NEPA analysis for any new or proposed mineral exploration and development projects.
American Clean Energy Resources Trust (ACERT)	225256	78	Page 4-83 Statement: *Only one (Pigeon Mine) of the five old uranium mines considered for cumulative impacts on the North Parcel lies within the calculated groundwater drainage area of a perched aquifer spring (Pigeon Spring). No data are available to assess current or past impacts to the spring. A water sample collected by the USGS prior to mining in 1982 showed that the total natural uranium concentration in water from Pigeon spring was 44.0 µg/L (Hopkins et at 1984b; see Appendix F, this EIS), which exceeds the EPA drinking water standard (30 µg/L)*Comment: In several sections of the EIS anomalous uranium or other metals in springs are attributed to nearby mines, apparently only because the mine and spring are in proximity, and there is no other evidence that the mine has affected the spring. Saying that the mine is definitely the cause of anomalous metals in the spring merely because of their proximity is a	There are no places in EIS Sections 3.4 and 4.4 where an impact on a spring is inferred to be definitely from mining activities simply because of proximity to the spring. These sections clearly characterize ambient concentrations detected in the proposed withdrawal area.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			fallacy of logic. A sample taken from Pigeon Spring, near the Pigeon Mine before mining took place contained anomalously high uranium concentrations. This shows that anomalous uranium can be present independent of mining.	
American Clean Energy Resources Trust (ACERT)	225256	79	Page 4-85 Statement: *Two R-aquifer springs are mapped immediately to the southeast (Miner's or Page Spring) and northwest (O'Neil Spring) from the Grandview Mine (Alter et al. 2009). No data are available from O'Neil Spring; however, data collected between 1981 and 2001 at Miner's Spring indicate that the average uranium concentration is 3.6 µg/L and the average arsenic concentration is 18.8 µg/L(see Appendix F). The uranium concentration is consistent with ambient levels for all small South Rim R-aquifer springs reported in Table 4.4-5; however, the arsenic concentration is about 9 µg/Labove the average concentration for small R-aquifer springs on the South Rim. Thus, it is possible, but cannot be confirmed as a result of a lack of pre-mining data, that the Grandview Mine has impacted Miner's Spring with respect to arsenic. Since ambient levels of arsenic in Miner's Spring may currently be above drinking water standards for arsenic (10 µg/L), another mine impacting Miner's Spring would not result in a change to the potential impact category for this alternative, which already shows a potential major impact Impact to uranium levels from mining would not be cumulative because the Grandview Mine has not impacted uranium levels. For the purpose of this analysis, it is assumed that conditions for O'Neil spring are similar to those for Miner's Spring.* Comment: Miner's Spring, below the Grandview Mine is said to have anomalous amounts of arsenic. It is possible that the arsenic is there because of the mine, however it is more likely that the arsenic is there from natural causes, i.e. it went into solution in the groundwater independent of the mine. At any rate to say that the mine caused the anomalous arsenic merely because of the proximity of the mine without any other evidence is a fallacy of logic. An example of anomalous metals independent of a mine is Pigeon Spring where a pre-Pigeon Mine water sample showed anomalous uranium unrelated to mining.	The DEIS text cited clearly states in Section 4.4.4 (Subsections Cumulative Impacts, R-aquifer Springs and Wells, South Parcel) that the anomalous arsenic concentrations detected at Miner's Spring cannot be confirmed to be a result of mining activities at the nearby Grandview Mine without pre-mining data. The FEIS more clearly states that the detected arsenic concentrations at Miner's Spring are not readily distinguishable from ambient levels.
American Clean Energy Resources Trust (ACERT)	225256	80	Page 4-87 Comment: North Parcel: With Alternative A the probability of impact is 13.2% (moderate). The range of values generally indicates more than an 80% probability that any spring would not be impacted. With Alternative B the probability of impact is 5.4% (moderate). The range of values generally indicates more than an 80% probability that any spring would not be impacted. East Parcel: With Alternative A the probability of impact is 1.3% (negligible). The range of values generally indicates more than a 95% probability that any spring would not be impacted. With Alternative B the probability of impact is 0%. Since there would be no new mines there will be no impact. South Parcel: With Alternative A the probability of impact is 0.2% (negligible). The range of values generally indicates more than a 95% probability that any spring would not be	Please refer to the response to comment 225256-69 (ACERT).

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			impacted. With Alternative 8 the probability of impact is 0.2%. Only the Canyon Mine will be developed. As explained in the text all the probabilities are overestimated (Section 4.4.1, page 52). This tends to bias the data in favor of Alternative 8 compared to Alternative A.	
American Clean Energy Resources Trust (ACERT)	225256	81	Pages 4-87 to 4-88 Comment: North Parcel: Under Alternative A the volume of water withdrawn from the mine-related Raquifer wells would be between 0% and 5%, over a 20-year period. This is based on 21 mines using 21 gpm which is 4.5% of the 470 gpm discharge from the Kanab and Showerbath springs. This amount of water from the springs is uncertain. Since the reach of these springs is diffuse, the reach is probably considerably larger. So the potential impact is likely negligible. Under Alternative B the volume of water withdrawn from the mine-related R-aquifer wells would be between 0% and 5%, over a 20-year period. In this case 10 mines would use 10gpm. Again, the impact is negligible. East Parcel: Alternative A the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This is an overestimate since the water flow into the Colorado River from the South Canyon walls is about 3,700 gpm, but there is flow from the other side and into the river from the R-aquifer directly. So the decrease is 0.1 % or negligible. Under Alternative B the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be 0%, over a 20-year period. South Parcel: Havasu and Blue Springs Under Alternative A the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This is a high estimate since the 7 projected mines will draw 7 gpm over the 20-year period. The Havasu Springs have a flow of 29,000 gpm and the Blue Springs complex flow is 46,000 gpm. Hence the impact is negligible for either of the springs. Havasu Springs only In Table 2.8-1, under Alternative B the volume of water withdrawn from the mine-related Raquifer wells downgradient from the mine would be between 0% and 5%, over a 20-year period. This range is unrealistically large, since the backup discussion indicates that the one mine that might impact the Havasu Springs would result in a decrease of 0.01% and would not even be measureable. South Rim Springs In Table 2.8-1, under Alternative A the volume of water withdrawn from the mine-related Raquifer wells downgradient from the mine would be between 0% to more than 10%, over a 20- year period. If the mines were located in the basins of the Hermit Springs or the Garden Springs, the flow from each is around 300 gpm, so the decrease in discharge would be less than 2%, which is negligible Other Springs Under Alternative B the volume of water withdrawn from the mine-related R-aquifer wells downgradient from the mine would be 0%, over a 20-year period. The summary table presents exaggerated ranges for the impacts under Alternative A. This is liable to mislead a number of readers. In all cases the impacts are negligible; this should be clarified.	Please refer to response to comment 225256-22 (ACERT).

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
American Clean Energy Resources Trust (ACERT)	225256	82	Pages 4-88 to 4-89 Comment: Under Alternative B at least one mine might contribute impacted water to the Raquifer; uranium and arsenic might exceed ambient levels but not drinking water standards. These results are obtained on the assumption that 5 mines "contribute 1 gpm of water containing 400 µg/Lof dissolved uranium and 90 µg of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs)." This would raise the projected concentrations from 4.9µg/L to 9µg/L for uranium and 2µg/Lto 3µg/L for arsenic. The lower figures in each range are the ambient concentrations. 1 . The assumptions do not seem realistic. Unless the mine was located next to Kanab or Showerbath springs, there would be considerable dilution due to distance and flow path, geochemical character of the groundwater, residence time of the solution in the aquifer, and other factors. The R-aquifer is very large, so dilution would be significant. 2. It should be noted that the impacts under both alternatives range from none to moderate. 3. Each mine would have to undergo rigorous scrutiny for a site-specific EIS.	Please refer to the response to comment 225256-71 (ACERT).
American Clean Energy Resources Trust (ACERT)	225256	83	Pages 4-88 to 4-89 Comment: East Parcel: Under Alternative A, zero to two mines might contribute impacted water to the Raquifer; uranium and arsenic might exceed ambient levels but not drinking water standards. These results are obtained on the assumption that one mine "contributes 1 gpm of water containing 400µg/L of dissolved uranium and 90 µg of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (west side Fence Fault complex in Marble Canyon)." This would raise the projected concentrations from 1.7µg/L to 1.8µg/L for uranium and remain at 10µg/L for arsenic. The lower figures in each range are the ambient concentrations. Under Alternative B there would be no impact, since there would not be any mines in this parcel. South Parcel: Under Alternative A, for Havasu and Blue springs, zero to one mine might contribute impacted water to the R-aquifer; uranium and arsenic would not exceed ambient levels. These results are obtained on the assumption that four mines "contribute 1 gpm of water containing 400µg/L of dissolved uranium and 90µg of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished." The ambient levels for uranium are 6µg/L for Havasu Springs and 7µg/L for Blue Springs. The levels for arsenic are 10µg/L for Havasu and 5µg/L for Blue Springs. These remain unchanged because of the contributions from the mines because of the large flows in these springs. Under Alternative A, for South Rim springs, zero to one mine might contribute impacted water to the R-aquifer; uranium and arsenic may exceed the EPA drinking water standards. For uranium the range might be 4 to 70µg/L and for arsenic it might be 10 to 30µg/L. The EPA MCLs for uranium are 30µg/L and for arsenic 10µg/L. Thus the impact ranges from none to major. For the Hermit Springs the range is between 3 to 4µg/L for uranium	Please refer to the response to comment 225256-71 (ACERT).

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			and for Garden Springs it is 3 to 5µg/L. The lower values are the ambient levels. For arsenic the ambient level for the Hermit Springs are 10µg/L, which is not impacted. Under Alternative B, for Havasu Springs only, from zero to one mine might contribute impacted water to the R-aquifer; uranium and arsenic may exceed the ambient levels. No mines would impact the other springs. 1. It should be noted that some of the springs are already at the EPA MCL for arsenic. 2. The assumption that the waters will reach the springs undiminished is not realistic. The R-aquifer is very large. 3. Each mine would be subject to strict scrutiny under a separate EIS, so either the mine would not be permitted, or adequate corrective steps would be incorporated.	
American Clean Energy Resources Trust (ACERT)	225256	84	Page 4-89 Comment: There is little impact to the quality of the surface water, except when the mine is located within the groundwater drainage area of a perched aquifer spring, especially if the spring is small. This applies to Alternatives A and B; only B will have no mines in the East parcel and only the Canyon mine in the South Portal. It appears that the analysis does not consider any dilution from the perched aquifer to the impacted mine water. It should be borne in mind that the mines use only 5 gpm of water, not all of which necessarily runs off and impacts the aquifer. Some of the water is used to allay the dust in the mine during drilling and comes out of the mine with the ore when it is brought to the surface. This ore is not dried out before shipping to the mill site, but some of the water evaporates into the atmosphere.	Please refer to the response to comment 225256-75 (ACERT).
American Clean Energy Resources Trust (ACERT)	225256	85	4.4.5 IMPACTS ON ALTERNATIVE B: PROPOSED ACTION: SURFACE WATER, QUALITY Page 4-89 Comment: The probability of a flood breaching a properly designed, constructed, and maintained berm over 20 years is about 4% (footnote page 4-80). So the primary mechanism of contaminant dispersal outside the mine perimeters is fugitive dust. Wind-deposited constituents could impact perennial streams or impounded surface waters by direct deposition. The dispersion of dust from the stored ore could be readily reduced by placing the ore in a covered area. The waste rock does not contain enough uranium to be a major problem (otherwise it would not be waste). Both types of rock are to be placed on concrete pads, as required by APP.	Please refer to the response to comment 225256-76 (ACERT).
American Clean Energy Resources Trust (ACERT)	225256	136	The Arizona Geological Survey has recently completed a study (Open file report OFR-11-04) of the worst case scenario of uranium ore entering the Colorado River. The report titled "Breccia Pipe Uranium Mining in the Grand Canyon Region and Implications for Uranium Levels in Colorado River Water" by Jon Spencer and Karen Wenrich is attached for inclusion in the final EIS, and consideration during the final review of the DEIS. A copy of an early release of this document is attached.	The potential water quality impact to the Colorado River is discussed in EIS Section 4.4.4 (Subsections Surface Waters, Water Quality). Although Spencer and Wenrich (2011) was not relied upon in conducting the EIS analysis of impacts to the Colorado River, the results of the analysis in this EIS are consistent with their findings.
Energy Fuels Resources	225260	22 & 23	Section 4.4.1, Springs: The assumption on page 4-49 that perched water in and around breccia pipes has any connection with the water that feeds	The conditions described in this comment are discussed in EIS Section 3.4.4, and conditions at the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the springs is not based on actual data but on theory. Based on my experience working in the mines, due to the inward dipping beds that surround a breccia pipe in the immediate vicinity of the breccia pipe, a perched aquifer is typically limited in area to the circumference of the pipe. Water that is encountered during mine development is generally minor and tends to flow into the workings through nearly vertical, concentric fractures that surround the pipe. The structural affects of the breccia pipes creates an aquifer boundary as described in the Manual of Applied Field Hydrogeology by Weight and Sonderegger, 2001, that has not been adequately studied in the preparation of the DEIS. Hydrostratigraphy, structural changes, and adjacent earth materials all affect groundwater flow and the separation of saturated materials into individual aquifer units. I believe that the perched water around the pipe falls into an individual aquifer unit and is not connected to the aquifer units that feed the individual springs. The perched water that is found around breccia pipes is trapped between the concentric fractures and the edge of the pipe. The interior of the pipes are dry. The initial inflow into the mine through the mine drifts that intersect the concentric fractures is relatively high, but rapidly diminishes as there is very little recharge through the fractures to this perched water and there is very little storage capacity, other than in the fractures. In most of the mines the perched water dries up completely due to ventilation of the mine and very little recharge. In the Pigeon Mine, there was some recharge at the end of mine life that was measured at about 0.8 gpm, which could be accounted for due to the close proximity of the Pigeon breccia pipe to the edge of Snake Gulch. It has been my observation, that due to the removal of gypsum and dissolution (karsting) of the limestone that occurs in the Kaibab and the Toroweap Limestone Formations when they are exposed along the canyons, the formations tilt into the canyons forming large open fractures that parallel the edge of the canyons. These open fractures account for the majority of water that feeds the various springs and just like in the mines, the only perched water storage is in the vertical fractures and along formational bedding planes and not in a horizontal lithologic horizon, which means the assumed watershed areas projected in the DEIS for the springs is excessive, based on theory and not supported by actual data. The DEIS also suggests that water flow into the mine workings, following reclamation, could affect the water flow to the springs in the area. First of all, even if there were a total of 30 mines opened up the actual volume of open mine workings in relation to the 1.1 million acres to be withdrawn is negligible and would have little to no impact on the flow to the springs.	few historic and existing breccia pipe uranium mines support these concepts. In addition, the conditions and processes at perched aquifers adjacent to breccia pipes described in this comment may occur at some fraction of the breccia pipes in the proposed withdrawal area. However, the location, conditions, and configurations of perched aquifers in the large study area for this EIS are not known with certainty. It is entirely possible that some perched aquifers may extend outside the immediate vicinity of a breccia pipe and may discharge at one or more perched springs. At these locations, the associated springs might be impacted if the breccia pipe would be mined. It is important to note that the site-specific NEPA analysis that would be required for a mine site would likely address and characterize this issue on a case-by-case basis. In the context of the current EIS for the proposed withdrawal, it must be assumed that hydraulic connections can occur between perched aquifers at breccia pipe and nearby perched aquifer springs. The perched springs in the study area are small, thin, and discontinuous; therefore, they rely on local recharge to relatively small groundwater drainage areas. The size of the EIS study area in relation to these small drainage areas is irrelevant. A single breccia pipe mine located in one such perched aquifer drainage area might impact the flow to any perched springs associated with that groundwater drainage area and aquifer.
Energy Fuels Resources	225260	24	On page 4-60, the use of data from and around the Orphan Lode Mine is inconsistent with the deposit's geomorphology and the mine's history. The Orphan Mine was on a single, patented lode mining claim located in 1893 for copper. There were three drifts driven in mineralized outcrops near the	The results of sampling Horn Creek springs below the Orphan Lode Mine are not used in the EIS to be representative of actual conditions at other past or current breccia pipe uranium mines in the proposed

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			north end line of the claim. In 1953, the USGS noted uranium in the old workings, which means the waste rock from the original mining operations that was dumped over the edge of the Grand Canyon contained uranium. In addition, the Orphan breccia pipe is eroded down into the Hermit Formation along the northeast edge of the canyon and undoubtedly uranium was eroded and was washed down the side of the Grand Canyon and into nearby drainages from on-going erosion. Therefore, it is probable that surface water running through the mine waste into the fractures that are parallel to the canyon and into the R-aquifer resulted in the anomalous uranium values; accordingly, it is unlikely that the reported uranium contamination is from water inside of the mine. Based on the USGS report, The Orphan Lode Mine, Grand Canyon, Arizona, A Case History of a Mineralized Collapse-Breccia Pipe, by William L. Chenoweth, Open-File Report 86-510, personal discussions with Mr. Chenoweth and personal observations in the eight Energy Fuels Nuclear mines I worked in, it appears that erosion over the Orphan Pipe resulted in the dissolution and transportation of secondary uranium mineralization occurred in and around the Orphan Mine. In addition, the mine was never reclaimed or sealed in; it was still accessible during the 1980's (based on personal experience). Storm water and runoff were allowed to further erode and transport the mine waste rock containing uranium into nearby drainages and down the side of the Grand Canyon. From a scientific standpoint, any data derived from spring samples or drainage samples in the area of the Orphan Mine cannot be relied upon to be valid or representative, or used for any assumptions as to exploration and mining impacts that occurred during the 1980's or any present or future exploration or mining activities.	withdrawal area; to the contrary, strong distinctions between this mine and 1980s and later mining are described in EIS Section 3.4.4. The sampling results are used as the best available data for the effects of mine drainage that has moved through breccia pipe mine workings and reached the R-aquifer at a location not far from the mine itself. The upper end of the range of uranium concentrations detected by Liebe (2003) at the "Horn up" location (400 ug/L) was used in the EIS to provide conservative analysis. The description given in the comment for redistribution of some of the waste rock and uranium into the tributary canyon is a reasonable account of what likely occurred. However, the conclusion that surface water runoff was the likely mechanism for migration of uranium into the R-aquifer that was measured by Liebe (2003) is not as supportable as other interpretations. After the mine was established, waste rock was also exposed to erosion and runoff. Storm water and runoff is of short duration, is subject to large and rapid evaporation losses, and only a small fraction infiltrates to provide groundwater recharge; therefore, the residence time of this water with the waste rock is short, limiting the opportunity for dissolution of the uranium. Thus, it is more likely that the water samples collected by Liebe (2003) directly from the spring at the base of the Redwall-Muav limestone contact ("Horn up" location) are derived chiefly from longer term contact of subsurface water moving through the mine workings, including surface water runoff that enters shafts and adits of the mine. Hom (1986) reported a uranium concentration of 620 ug/L in a sample of water collected in May 1985 in an adit from the base of the Coconino Sandstone, which may be related to a local perched aquifer. Please refer to Appendix H for a detailed discussion of the Orphan Lode Mine and isotopic data collected at Horn Creek.
Energy Fuels Resources	225260	25	At the bottom of page 4-60 the assumptions regarding mine drainage reaching the R-aquifer appear to be unrealistic as stated above. For example, the second bullet assumes a very high uranium concentration of 400µg/L reaching the Raquifer, even though most breccia pipes are separated from the R-aquifer by many hundreds of feet of Hermit Shale and other confining layers. It needs to be emphasized that the Orphan Mine is a unique situation where the mine is actually located on the edge	The EIS emphasize the unique characteristics of the Orphan Lode Mine in Section 3.4.4. Please refer to the responses to comments 225256-71 (ACERT) and 225260-24 (EFR).

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			of the Grand Canyon and was operated during a time when minimal government regulations were implemented to mitigate potential contamination. The last bullet assumes that there is no attenuation or dilution occurring, although they would occur and can be added to the model. It is recommended that the model be revised to more closely reflect the characteristics of the breccia pipes that were mined during the 1980's under Plans of Operation approved by federal and state regulators and include the hydrogeology of the area and the natural processes that tend to reduce environmental impacts.	
Energy Fuels Resources	225260	26	On page 4-63 paragraph under "Wells" the following statement is made "Although possible, these impacts are not considered likely because of the removal of contaminated sump water during mining, reclamation of the mines, monitoring, and the low permeability conditions that typically occur in the breccia pipe and in the hundreds of feet of intervening rock formation between the aquifer and the mine openings. Because data are insufficient to estimate the specific flow paths and dilution in the aquifer at future mines, it is not possible to quantitatively project the potential impacts to chemical quality at non-mine Raquifer wells, if such impact were to occur. Therefore, it is assumed that the potential impact would range from none to major." Without knowledge that this can even occur, how can it be considered a potential major impact? Similarly, projected moderate to major impacts to surface water quantity and quality are equally flawed by the assumption that if a mine is close to a water source, that water source will inevitably be negatively impacted. Simply put, the regulations require baseline characterization of surface water and do not allow for these types of impacts to occur.	As inferred in the text cited in this comment, due to the uncertainty regarding the range of subsurface conditions over the large study area and the location of future mines and wells, it is assumed that an impact is possible to groundwater quality at wells. If an impact is possible, but cannot be quantified, it must be assumed that the impact might or might not exceed thresholds for drinking water, which would constitute as much as a major impact. Impacts are not characterized in the EIS as being "inevitable", but are analyzed with respect to specific conditions, including hydrologic boundaries, etc,., within each parcel. The basis for the impact categories is given in EIS Section 4.4.1 and defined in Table 4.4-1; the categories assigned to each parcel under each alternative are given in Table 4.4-3 and explained in the corresponding text. The methodology and analysis are consistent and reasonable for the purposes of the EIS. The regulations provide the mechanism for prevention and mitigation of impacts; implementation of the regulations must fit each site on a case-by-case basis as determined from site-specific analysis during the NEPA process.
Energy Fuels Resources	225260	27	Section 4.4.4: The method for determining degree of impact on perched aquifer springs is based on the probability of a mine occurring in the vicinity of a perched aquifer spring. Based on the number of mines assumed in the North Parcel, a moderate impact is projected in the second paragraph of page 4-68 for Alternative A. However, this methodology does not take into account the groundwater and surface water characterizations that are performed as part of state and federal permitting process and the mitigation measures that would be included in a plan of operations located in close vicinity to a spring. Furthermore, most springs that are connected with mineralized areas tend to have naturally poor water quality prior to the advent of any mining.	Please see the response to comment 225260-26 (EFR). In addition, in EIS Section 3.4.7, it is acknowledged that the ambient quality of perched groundwater near mines is generally poor as a result of mineralization from the ore bodies. However, this condition does not mean that perched springs fed by such groundwater are not an important source of water to wildlife and vegetation, or occasionally to humans. The EIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities, and Appendix B, Reasonably Foreseeable

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				Development Scenarios, Section B.3, Regulatory Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
Energy Fuels Resources	225260	28	The method for determining impacts to wells located within a perched water system relies on similar assumptions (i.e., probability that such a well might be located near a mineralized breccia pipe). And, as discussed on page 4-71, the risk of impacting such a shallow well in the North Parcel was stated as 'no impact to major impact." As discussed above, permit conditions and mitigation measures are designed to limit and mitigate impacts; accordingly, projecting a moderate or major impact to existing wells is inconsistent with the regulatory requirements.	Please see the response to comment 225260-26 (EFR).
Energy Fuels Resources	225260	29	The assumption that up to half the mines might contribute 1 gpm of water containing elevated metal concentrations to the R aquifer (see pages 4-60 and 4- 75) are not justified given the presence of thick aquicludes (hundreds of feet of Hermit Shale and other shale units) between the breccia pipe deposits and the aquifer. Accordingly, predictions of moderate impacts to the water quality of the R aquifer are not technically supportable.	EIS Section 4.4.1 (Subsection Chemical Quality of Regional R-aquifer Springs and Wells) addresses the low risk of impacts to the R-aquifer water quality. However, due to the potential variability of subsurface conditions over the large study area for which available data are limited, we cannot assume that this risk is zero at all potential mine locations. The assumptions, methodology, and analysis given in EIS Section 4.4.1 were used in an effort to quantify the potential impact, if such contamination were to occur. The impact analysis accounts for a range of potential conditions, not just the upper end projection. Please see the response to comment 225269-3 (ADEQ) regarding the assumption of 1 gpm.
Uranium Watch	225262	16	Section 2.8, Comparison of Alternatives; Table 2.8-1, Summary of Potential Environmental Impacts by Alternative; Water Resources. Page 2-33. There is no discussion of the extent to which existing and potential uranium mines would be in areas where water would enter the mine, requiring the mines to be dewatered during the life of the mining operation. Therefore, there is no assessment of the potential for contaminated mine water that is held in evaporation ponds or discharged offsite to impact the quality and quantity of water resources. Mine dewatering and the need to remove radium and uranium from mine water prior to discharge under a state or federal Pollutant Discharge Elimination System permit is an essential part of the operation of a uranium mine that is subject to drainage and flooding. There is no basis for the assumption that contaminated mine water would not be discharge off site. Offsite discharge has the potential to adversely impact ephemeral and permanent watercourses, riparian vegetation, and animals that drink from those water sources and consume the vegetation.	EIS Section 4.4.1 addresses the probability of mines being located in areas of perched groundwater (Subsection Quantity of Discharge from Perched Aquifer Springs and Wells), as well as the amount of drainage assumed to enter a mine (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells). In effect, the analysis assumes that any mine might be subject to a small amount of groundwater drainage from perched aquifers. As described in EIS Section 4.4.3, off-site discharges are not permitted under the Aquifer Protection Permit program administered by ADEQ. Because no discharges are permitted, there is no federal Pollutant Discharge Elimination System permit required for the breccia pipe uranium mines in northern Arizona.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Uranium Watch	225262	19	Section 3.1.7 Resource Condition Indicators; Table 3.1-1; 3.2 Water Resources; Dewatering or contamination of shallow perched aquifers; Description of Relevant Issues. Page 3-4.This section fails to discuss the potential impacts of the discharge of mine water on the surface.	As described in EIS Section 4.4.3, off-site discharges are not permitted under the Aquifer Protection Permit program administered by ADEQ. Because no discharges are permitted, there is no federal Pollutant Discharge Elimination System permit required for the breccia pipe uranium mines in northern Arizona.
Uranium Watch	225262	25	Section 4.1.1 Foreseeable Activity Assumptions. Pages 4-1 to 4-2. The DEIS does not provide information regarding how hydraulic gradients will be reestablished and how mine drainage over time will be prevented. This information should be included in the EIS.	EIS Section 3.4.4 and Section B.4.5, Appendix B, address sealing of the mines to prevent mine drainage.
Uranium Watch	225262	35	Section 4.2. Air Quality and Climate. Pages 4-4 to 4-36. The DEIS discussion of Impacts Common to All Alternatives (Section 4.2.4, page 4-16) manages to totally ignore the radioactive and hazardous constituents of any fugitive dust from the mining operation. The EIS must identify all hazardous radioactive and non-radioactive constituents of fugitive dust from the uranium mining operations and assess their impact on the environment. This would include an evaluation of potential exposure pathways and impacts to the public, workers, ground and surface water, soils, vegetation, and native and domestic animals over the short and long term.	Impacts to water from fugitive dust are discussed in the EIS in Section 4.4.4, under the sub-heading “Surface Waters – Water Quality”, for projected potential impacts related to future mining. The composition of the particulate matter in fugitive dust would be expected to vary based on many factors that cannot be reasonably estimated. Thus, the EIS uses uranium and arsenic concentrations detected in soil samples collected around previous mine sites as a proxy for overall contamination impacts from fugitive dust. This approach is supported by the findings of Otton et al 2010, which concluded that uranium and arsenic "were consistently the most abundant trace elements of concern at mined sites." In addition, data for other constituents, particularly background values in the area, are sparse and thus it is not feasible to incorporate them into the analysis.
Uranium Watch	225262	54	Section 4.4.3 Compliance with Environmental Regulations and Permitting (page 4-66) states, "*Active mine sites are routinely audited for compliance with their approved plans of operation and other permits."* This section should state who does the auditing, what constitutes an "audit," how often "audits" occur, what happens when the mine owner or operator in not in compliance. This section should also introduce the concept of mine inspections and provide information about mine inspections, including who inspects the mine operations, how often, the extent of the inspection, and the regulations that must be complied with. The history of the Arizona 1 Mine is indicative of the compliance audits at uranium mines in Arizona. The ADEQ did not inspect the mine until it had been operating for 9 months. The ADEQ only inspect the surface operation and found 1) There were no pumps in the mine to eliminate any water there, 2) a test measuring the permeability of the rock in the mine hadn't been done, 3) a pipe was sticking through a lined pond that is intended to prevent groundwater contamination from ore or water pumped out of the mine, and 4) plans for the mine didn't match what inspectors found when they visited.	This EIS is an analysis of a mineral withdrawal proposed by the Secretary of Interior and two alternative withdrawals. No specific mine operations are being addressed, nor will any be authorized as a result of this analysis. The description of mine inspections and other techniques (mitigations) to reduce environmental impacts and assure compliance to laws and regulations would be established at the time of the site-specific NEPA analysis of a new Mine Plan of Operations. The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM’s jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, and National Park Service have agreed to initiate formal talks with ADEQ

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			2 Also, the ADEQ had unfilled requests for documents and inspections by engineers that it sought before the mine opened.	so that all four agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park. In the specific instance cited in this comment regarding the Arizona 1 mine, ADEQ has responded and is addressing the situation (see: http://www.azdeq.gov/environ/air/permits/download/denison/response.pdf)
Uranium Watch	225262	55	Section 4.4.3 fails to describe the BLM and USFS inspection and regulatory program for operating uranium mines on the north and south rims of the Grand Canyon. The EIS should fully describe the BLM and USFS current inspection and regulatory program for the Arizona 1 Mine. The EIS should fully describe the BLM and USFS inspection and regulatory program for future uranium mining activity in the withdrawal area.	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. The BLM and Forest Service regularly inspect mining operations. The BLM, under the 3809 Surface Management Regulations, inspects active operations two times per year, at a minimum, and conducts more frequent inspections when necessary. The minimum number of inspections for active operations on Forest Service lands is one time per year with more frequent inspections when necessary.
Uranium Watch	225262	56	The information in Section 4.4.3 related to the ADEQ's regulation of uranium mines is invalid without a full assessment of how the ADEQ has monitored the Arizona 1 Mine and fulfilled their regulatory commitments and the implemented the practices listed in this section at pages 4-66 and 4-67.	Please refer to the response to comment 225262-54 (Uranium Watch).
Uranium Watch	225262	57	The EIS should provide information regarding Pollutant Discharge Elimination System permitting and ground water discharge permitting under federal and state regulatory programs at uranium mines in Arizona	As described in EIS Section 4.4.3, off-site discharges are not permitted under the Aquifer Protection Permit program administered by ADEQ. Because no discharges are permitted, there is no federal Pollutant Discharge Elimination System permit required for the breccia pipe uranium mines in northern Arizona.
Uranium Watch	225262	58	The EIS should provide information on the types of groundwater treatment facilities, the potential for ground and surface water contamination from such facilities, the radioactive emissions to the atmosphere from such facilities, the disposal of radioactive waste from such facilities, the impacts to ground and surface of water from the release of treated mine off site from water treatment facilities, and an evaluation of all environmental impacts from the water treatment facilities and the release mine water containing uranium and radium into the environment.	As described in EIS Section 4.4.3, off-site discharges are not permitted under the Aquifer Protection Permit program administered by ADEQ. Uranium mines do not have groundwater treatment facilities; all discharges are contained in on-site evaporation ponds.
Uranium Watch	225262	59	This section only considers the impacts on water quality from uranium operation for constituents of uranium and arsenic. The EIS must also address the amount of and impacts from radium and other pollutants in the mine water discharge. The EPA has established a standard for effluent	As described in EIS Section 4.4.3, off-site discharges are not permitted under the Aquifer Protection Permit program administered by ADEQ. Because no discharges are permitted, there is no federal Pollutant

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			from uranium ores.3 This applies to following pollutants discharged in mine drainage: uranium, zinc, radium-226 (dissolved), radium- 226 (total), total suspended solids (TSS), pH, and chemical oxygen demand (COD). The EIS must evaluate mine drainage from the uranium mines in the withdrawal area for these constituents.	Discharge Elimination System permit required for the breccia pipe uranium mines in northern Arizona. Please refer to the response to comment 225262-35 (Uranium Watch).
Uranium Watch	225262	60	The discussion of Surface Waters (Section 4.4.4, page 4-78 to 4-79) lists potential impacts to surface waters. There is no basis for the assumption in the DEIS that no mine water will be discharged off site. This section should include the potential impacts to surface waters from the discharge of treated mine water off site under a Pollutant Discharge Elimination System permit. This assessment must also include an assessment of the impacts from uranium, zinc, radium-226 (dissolved), radium-226 (total), TSS, pH, and COD, pursuant to 40 C.F.R. Part 440, Subpart C. This assessment must include an assessment of the discharged water on stream function, sediments, riparian habitat, wildlife, and livestock.	As described in EIS Section 4.4.3, off-site discharges are not permitted under the Aquifer Protection Permit program administered by ADEQ. Because no discharges are permitted, there is no federal Pollutant Discharge Elimination System permit required for the breccia pipe uranium mines in northern Arizona. Please refer to the response to comment 225262-35 (Uranium Watch).
Uranium Watch	225262	61	This section should include the potential impacts to surface water from the emission of radon and radioactive particulates from the mine. The dispersion of uranium, radon, and other radionuclides in the air from the mine will result in the uptake of those radionuclides in soil and ground and surface water. The impacts of that dispersal on surface and ground water must be evaluated.	Please refer to the response to comment 225262-35 (Uranium Watch). There is relatively little potential for radon that might be released from the cited sources to contaminate soils and water. Most soils naturally release radon into the atmosphere, and it is unlikely that radon emissions from mine-related sources would result in accumulation of radon in soil or surface water because it is a gas, not a particulate.
Arizona Mining Association	225266	7	Section 1.3.1 The Purpose of the Proposed Action is described as *to protect the natural, cultural and social resources in the Grand Canyon watershed from the possible adverse effect of the reasonably foreseeable locatable mineral exploration and development that could occur in the segregated area.* The Need for Action is described as *concerns that future hardrock mining activities in the Grand Canyon watershed, particularly for uranium, could result in adverse effects on resources.* However, this section acknowledges that environmental impacts were from historic mines, namely the Orphan Mine on the south rim of the Grand Canyon, that date back to the 1860's that were operated prior to the adoption of new regulations and permitting requirements that govern mining on federal lands. As noted in ARPA's comments, the United States Geologic Survey (USGS) and the Arizona Geologic Survey (AGS) have noted that the amount of uranium naturally eroding into the watershed from exposed breccia pipes far exceeds both the historic releases of uranium from past mining operations and any reasonably anticipated releases of uranium from future mining activity.	The comment misrepresents what has been noted by USGS and AZGS. The total contribution of uranium to the Grand Canyon region watersheds from natural erosion of exposed breccia pipes is large and causes an average ambient concentration in water and soils. This average ambient concentration might be exceeded at specific mine sites. Although current regulations are generally effective for mitigating impacts, there is no guarantee that all potential impacts can be eliminated. Please refer to response for 225280-13 (ASLD).
Pew Environment	225274	4	While we understand that the Department cannot predict precisely which springs might be at risk, we believe that the DEIS should recognize that	The DEIS does recognize that potential impacts to many small springs and seeps in the area, even if

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Group			even temporary loss of an individual spring could have serious repercussions for the Park area's species diversity. Even if spring flows are eventually restored, species loss could be permanent.	small in magnitude and temporary, represents up to major potential consequences. See Section 4.4.1 (Subsection Chemical Quality of Perched Aquifer Springs and Wells) and Section 4.4.4 (Subsection R-aquifer Springs Quality) in the EIS.
Pew Environment Group	225274	6	The assessment should also evaluate the impact that groundwater pumping from multiple mines over many years could have on future demands for groundwater supplies, considering those demands along with potential demands from further population growth.	The potential impact from pumping R-aquifer mine wells on other R-aquifer wells is analyzed in Section 4.4.4 (Subsection R-aquifer Wells Quantity and R-aquifer Wells Quality) in the EIS. Potential cumulative impacts are addressed in Section 4.4.4 (Subsection Cumulative Impacts – Groundwater).
Pew Environment Group	225274	7	On the issue of water quality, we understand that local factors affecting fate and transport of contaminants into the environment differ from some other areas that have experienced long term water contamination problems, but we were disappointed to see that the study gives little consideration to the role of flash flooding or the potential for cross-contamination of shallow and deeper aquifers via existing, abandoned or future wells. We were also disappointed with the broad assumption that contamination may be acceptable because of high volume flows in and to the R-aquifer, and with what we believe may be a misinterpretation of the USGS water quality studies in the area.	It is assumed that this comment is referring to surface seals that prevent surface waters from passing down wells. The Arizona Department of Water Resources (ADWR) regulates well drilling practices in Arizona and requires proper surface seals. This issue is discussed in EIS Section 4.4.1 (Subsection Quantity of Discharge from Perched Aquifer Springs and Wells – Wells). The EIS makes no assumptions regarding the acceptability of any projected potential impacts. As a Cooperating Agency in the EIS process, USGS has been an active participant, reviewing all draft versions of the EIS and analysis to assure their data has been appropriately represented and used.
Pew Environment Group	225274	8	USGS carried out research and field work, dealing with time limitations and weather constraints that kept them from taking new surface water samples. Their investigation does not, as some industry representatives state and the DEIS implies, offer solid evidence that past mining has not resulted in contamination. To the contrary, their results show elevated radioactivity at all of the sites investigated, with the exception of Jumpup Canyon, which was selected as a background comparison site. The USGS scientists are careful to point out, however, that these limited investigations are not conclusive and that additional data as well as a more complete understanding of groundwater flow patterns in the area would be required to draw solid conclusions.	The DEIS makes no assertions, implied or otherwise, that the USGS report offered conclusive evidence that past mining resulted in no impacts.
Pew Environment Group	225274	18	Two reports produced by mining engineer Jim Kuipers and geochemist Ann Maest and reviewed by mining experts emphasize the inherent difficulties of predicting "and therefore preventing" water quality impacts at hardrock mines. In their study of predicted and actual water quality impacts at 25 hardrock mines, the scientists found that mining-related exceedences of surface water quality standards occurred at 60% or 15 of the 25 mines. Of those, nearly three-quarters predicted that exceedences could be avoided with appropriate mitigation; others actually predicted that	It should be emphasized that the conditions at many mining districts are unique and it can be misleading to make generalizations among such areas. This concern is especially valid for the breccia pipe uranium mines in the Grand Canyon region because they are truly unique compared to the locations discussed in the papers cited in this comment. It is not appropriate to lump concerns for those other areas into potential

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			mitigation would not be necessary. Only one mine correctly predicted a moderate potential for exceedences. The results for groundwater impact predictions were similar, with 64% or 16 mines experiencing exceedences of groundwater quality standards. Of these mines, 77% or 10 mines had predicted low potential for groundwater impacts. While these reports were not specifically focused on uranium mines per se, these findings are relevant to the mining operations in the Grand Canyon region, where each mine will likely encounter a number of different minerals as well as radionuclides, and in some cases, present a potential for creation of acid mine drainage. The studies are particularly pertinent, given the considerable uncertainties in the mechanics of groundwater flows through the region and the lack of information on the extent of contamination from past operations on the Arizona Strip. See Predicting Water Quality at Hardrock Mines: Methods and Models, Uncertainties, and State-of-the-Art, the direct yearly employment associated with Grand Canyon National Park travel http://www.swrcb.ca.gov/academy/courses/acid/supporting_material/predictwaterqualityhardrockmines1.pdf and Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements, http://www.earthworksaction.org/pubs/ComparisonsReportFinal.pdf.	concerns for this area of northern Arizona without carefully analyzing the significant differences in the ore deposits, methods of mining, permitting, and hydrogeological conditions.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	5	The DEIS fails to analyze a worst-case scenario for aquifer contamination. The U.S. Geological Survey (USGS) Hydrology report noted that, "The Hermit Mine sump concentrations ranged from 3,310 to 36,600 µg/L (the highest reported value of any sample type in this study) in 1989-90 (figs. 9A, 13)" and "These high concentration mine shaft and sump waters may be sources of dissolved uranium for nearby sites if mine water is capable of entering the regional groundwater flow system." Hydrology report at 184. Rather than evaluating such a scenario, the DEIS relies on much lower dissolved uranium concentrations observed at the Orphan Mine to predict ground water pollution. The DEIS altogether ignores the potential impact of rapid recharge events flushing water through mined pipes into ground water flow systems.	NEPA does not require development of worst-case scenarios. The worst case analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618 (Apr. 25, 1986). CEQ Regulations require analysis of reasonably foreseeable impacts, not worst-case scenarios. The justification for the uranium concentration used in projections of potential impacts is given in EIS Section 4.4.1 (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells – Springs). The operational and reclamation procedures required under state and federal permits are designed to prevent the entrance of surface water into breccia pipe uranium mines; therefore, a rapid recharge event that would flush water through such a mine is not a reasonably foreseeable event. There are no accounts of rapid recharge events flushing water through mined breccia pipe uranium deposits in the proposed withdrawal area. In addition, as stated in EIS Section 3.4.4, subsurface conditions at these sites are not favorable for the downward migration of leached minerals and other constituents from the mine openings.
Grand Canyon	225279	6	The DEIS rejects high "outlier" samples of legacy pollution in its	The "outlier" water sample referred to in this comment

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity			assessment of potential future impacts to ground water but then relies on a single high outlier sample to double natural background soil uranium concentrations over USGS definitions. This methodology (discarding outliers in one case, relying on them in others) downplays potential mining impacts by reducing foreseeable pollution and the amount of that pollution that can be attributed to anthropogenic rather than natural sources.	is not legacy pollution, but simply a sample of water collected from the sump of an operating mine (Hermit Mine), which was routinely pumped to the land surface for evaporation in the lined surface impoundment, per the mine permit requirements. See the response to comment 225279-5 (CBD and others) for reference to the pertinent section where this sump water sample is discussed. Refer to the response to comments 225279-22 (CBD and others) and 225279-23 (CBD and others) regarding reported soils background data.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	7	The DEIS employs small, fixed capture radii to assess the potential impact of mines to perched aquifers; fixed radii ignore the potential for much larger capture zones resulting from groundwater moving greater distances along fractures, fissures and impermeable strata prior to discharging at seeps and springs. This is especially true of rapid recharge events.	The buffer areas were not utilized directly in the calculation of impact probability. Rather, the buffer areas were used in development of the alternative withdrawal areas (Alternatives C and D), which are factored into the calculation of impact probability, and to assess potential impacts at existing mines. Text in DEIS Section 4.4.1 (Subsection Quantity of Discharge from Perched Aquifer Springs and Wells, Springs) on pages 4-51 and 4-52 indicating that buffer areas were used for calculating probability of impact is incorrect and was modified in the FEIS. The radii of the buffer areas are not fixed except for springs with a reported discharge of 1 gpm or less (in such cases the discharge is assumed to be 1 gpm) or are only the same for perched springs having the same reported discharge. As described in Section 4.4.1, the estimated groundwater drainage areas are conservatively large. This overestimates the potential area of impact, and therefore reasonably accounts for the potential extent of unknown recharge pathways.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	11	Grand Canyon's Black Swan: Worst-case Pollution Scenarios The DEIS fails to anticipate system failure "regulatory, engineering or otherwise" relating to uranium mines around Grand Canyon. It naively presumes that existing regulatory mechanisms are adequate, compliance with existing regulatory mechanisms will occur, that compliance can or will be monitored or enforced, and it presumes that the existing regulatory mechanisms themselves are adequate. As we discuss later, none of those assumptions are true. The DEIS presumes that the maximum possible discharge of uranium-contaminated water into deep aquifers is one gallon per minute of 400 micrograms per liter uranium concentrations. This ignores the possibility of much higher dissolved uranium concentrations moving into ground water systems (like the Hermit Mine sump's concentrations of	NEPA does not require development of worst-case scenarios. The worst case analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618 (Apr. 25, 1986). CEQ Regulations require analysis of reasonably foreseeable impacts, not worst-case scenarios. Regarding concentrations of uranium and recharge events refer to the response to comment 225279-5 (CBD and others).

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Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			36,000 micrograms per liter) and it ignores the possibility of a rapid aquifer recharge event flushing much higher volumes of water though mined or explored ore bodies and into ground water flow systems in very short time periods	
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	12	Grand Canyon's Black Swan: Worst-case Pollution Scenarios. The DEIS also avoids discussion of the monumental tasks and hundreds of millions or billions of dollars required to clean up deep aquifer contamination, assuming it is even possible. Commenting organizations raised this issue in scoping. Neither the federal government nor industry can guarantee that uranium mining would not deplete or contaminate aquifers. The failure of industry and federal clean-up efforts to remediate shallow uranium-contaminated aquifers in the Four Corners region casts significant doubt on their ability to remove uranium pollution in aquifers thousands of feet below the Grand Canyon region's rock strata. The failure of past cleanup attempts and the almost certain impossibility of remedy in Grand Canyon's aquifers warrants caution to preclude any mining or exploration that carries with it even the most remote potential for aquifer damage.	NEPA does not require development of worst-case scenarios. The worst case analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618 (Apr. 25, 1986). CEQ Regulations require analysis of reasonably foreseeable impacts, not worst-case scenarios.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	16	Nor are ADEQ Aquifer Protection Permits for existing uranium mines in the withdrawal area adequate to protect ground water resources because: (1) Mine shaft water monitoring is required only quarterly, thereby precluding detection of pollution problems for up to three months following pollution events; (2) Permits do not require down-gradient aquifer monitoring to detect contamination plumes in perched and deep aquifers; (3) Permits do not require remediation plans to determine the measures, resources and procedures needed to correct perched or deep aquifer contamination; (4) Permits lack sufficient bonding to ensure that resources exist to implement nonexistent remediation plans upon detection of perched or deep aquifer contamination. Long monitoring intervals preclude immediate pollution detection; lack of aquifer monitoring precludes aquifer pollution detection; lack of remediation plans and bonding preclude pre-planning and resource availability for aquifer remediation. Remediation of deep aquifers is likely impossible in the event of uranium pollution; remediation of perched aquifers is likely cost-prohibitive, particularly absent bonding. BLM's assertion that ADEQ's administration of Aquifer Protection Permits precludes the possibility of pollution of aquifers and receiving surface waters is, like its other claims of regulatory adequacy and compliance, dubious at best.	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, and National Park Service have agreed to initiate formal talks with ADEQ so that all four agencies may come to agreement as to how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center	225279	17	The DEIS established a principle for hazard avoidance in its discussion of impacts to American Indian resources. It states: Since damage to traditional cultural and sacred place is irreversible, the preferred mitigation measure is avoidance. DEIS at 4-210. The DEIS should apply the hazard avoidance principle to aquifer contamination. Aquifer contamination, if it did occur, would be irreversible. It would be impossible to clean up. State and federal agencies cannot guarantee against such a result if mining is	The way the Arizona Department of Environmental Quality monitors compliance with the laws and regulations they administer is not within BLM's jurisdiction. In an effort to address this concern, however, the BLM, Forest Service, and National Park Service have agreed to initiate formal talks with ADEQ so that all four agencies may come to agreement as to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
for Biological Diversity			allowed to continue. Here too the preferred mitigation measure should be avoidance.	how to best coordinate their monitoring and enforcement efforts in and around Grand Canyon National Park. Hydrogeologic conditions in the perched aquifers or the R-aquifer in the proposed withdrawal area would not preclude effective remedial actions to mitigate groundwater contamination.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	18	The DEIS contradicts the 2010 USGS hydrology report prepared for the proposed withdrawal; the DEIS fails to reconcile that contradiction. The 2010 USGS report states that breccia pipes are conduits for downward movement of water through ore bodies and into groundwater. Fractures, faults, sinkholes, and breccia pipes occur throughout the study area and are pathways for downward migration of surface water and groundwater. Collapse features and breccia pipes in particular can intercept precipitation, runoff, and groundwater in perched water-bearing zones and can direct that water deeper into the subsurface. In areas containing mineralized pipes, this process can dissolve trace elements and radionuclides in the deposits and transport them to groundwater deeper in the subsurface. USGS 2010 Hydrology Report at 147. These findings are consistent with generally accepted principles of groundwater recharge in the region. Conversely, relying predominantly on unpublished industry reports and personal communications with uranium industry personnel, the DEIS claims that breccia pipes are impermeable. DEIS at 3-57. In making this pronouncement, the DEIS fails to acknowledge contradictory information or explain the differing propositions. The DEIS then relies on a notion of impermeable breccia pipes to downplay the potential for aquifer contamination by uranium mining. This in turn downplays the potential impacts from uranium mining to receiving surface water and associated species and ecosystems throughout several analyses set forth in Chapter 4 of the DEIS. Worse, the DEIS (BLM, we presume) fails to discuss the discrepancy in breccia pipe permeability or disclose the industry reports upon which it relies in its contradiction of USGS. BLM further fails to discuss the discrepancy between industry claims about breccia pipe permeability and congressional testimony by Dr. David Kreamer and Dr. Abe Springer cited in commenting organizations' scoping comments.	The EIS relies on the best data available and the data used is cited in Chapter 6. Because mining industries have conducted most of the research and exploration on breccia pipe uranium deposits in northern Arizona and their consultants have investigated conditions in operating mines, it is necessary and appropriate to incorporate and rely on data and reports available from the mining industries and their consultants, as well as more publicly available publications by USGS and other agencies. As a Cooperating Agency in the EIS process, USGS has been an active participant reviewing all draft versions of the EIS and analysis to assure their data has been appropriately represented and used. The testimony cited in the comment by university professors Drs. Springer and Kreamer was considered during the preparation of the EIS, but did not contain new or additional information pertinent to the analysis. EIS Section 3.4.4 discusses conditions associated with economically viable breccia pipe uranium deposits. The EIS does not characterize breccia pipes as "impermeable" and, in fact, makes the conservative and unlikely assumption to project potential impacts that continuous drainage of uranium-containing water occurs at up to half of the mines projected in the RFD.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological	225279	19	The DEIS excludes the highest dissolved uranium samples compiled by USGS from consideration of pollution that could contribute to groundwater contamination: Based on their 2009 water quality sampling study, which included sampling of the Pinenut and Canyon mine wells, Bills et al. (2010) concluded that relationships between the occurrence of dissolved uranium and 13 other trace elements and mining activities were few and inconclusive. Therefore, the concentrations in the Hermit Mine sump were not considered representative for post-mining drainage at mines in the	Regarding concentrations of uranium used in the analysis, refer to the response to comment 225279-5 (CBD and others) and 225260-24 (EFR). The appropriate methodology for the EIS is to use the best available data to project reasonably foreseeable impacts. Use of the Hermit Mine sump data would not be a reasonable and foreseeable impact and would not meet these criteria because: 1) concentrations in the

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Diversity			proposed withdrawal area, nor would similar concentrations be expected in Raquifer groundwater. DEIS at 4-61. The purpose of the DEIS is to anticipate effects that could attend future mining, not to constrain that analysis to documentation of past effects in the face of admitted uncertainty and inadequate past monitoring. The DEIS narrative rejects the Hermit Mine sump data despite the USGS' characterization of contaminated sump water at Hermit Mine and the threat of it moving into groundwater flow systems: The Hermit Mine sump concentrations ranged from 3,310 to 36,600 µg/L (the highest reported value of any sample type in this study) in 1989-90 (figs. 9A, 13). These high concentration mine shaft and sump waters may be sources of dissolved uranium for nearby sites if mine water is capable of entering the regional groundwater flow system. USGS hydrology report at 184. The USGS clearly contemplates the possibility for water to move through breccia pipes, like the Hermit Sump, into ground water flow systems: Fractures, faults, sinkholes, and breccia pipes occur throughout the study area and are pathways for downward migration of surface water and groundwater. Collapse features and breccia pipes in particular can intercept precipitation, runoff, and groundwater in perched water-bearing zones and can direct that water deeper into the subsurface. In areas containing mineralized pipes, this process can dissolve trace elements and radionuclides in the deposits and transport them to groundwater deeper in the subsurface. USGS 2010 Hydrology Report at 147. After rejecting contamination values from the Hermit Mine sump from the analysis, the DEIS narrative then relies on contamination values detected at the Orphan mine to characterize the potential for groundwater contamination. Those values are 400 µg/L; the 36,600 µg/L value recorded at the Hermit Mine sump is excluded from analysis. Again, the effect of the DEIS' methodology is to downplay the potential for uranium mining related pollution, thereby downplaying the potential for that pollution to impact receiving surface waters and related species and ecosystems in Grand Canyon National Park.	sump would be expected to be higher during mining than after mining is complete; and 2) if there is mine drainage, the sump water is pumped to the evaporation pond during mining. There is no evidence that the sump water migrated downward through the low permeable rock to the R-aquifer. None of the studies of groundwater impacts for breccia pipe uranium mines, including long-term monitoring data for onsite mine wells, in the proposed withdrawal area have concluded that mine operations have impacted the R-aquifer. Therefore, the independent clause ("if" statement) in the USGS sentence cited from page 184 is not likely to occur during mining operations and is not reasonable and foreseeable. Regarding groundwater movement through economically viable uranium deposits, refer to the response to comment 225279-18 (CBD and others) and EIS Section 3.4.4.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	20	In order to serve and inform the purpose and need of the withdrawal EIS, which is *"to protect the Grand Canyon watershed from adverse effects of locatable hard-rock mineral exploration and mining,* the EIS must reasonably define and analyze a worstcase scenario for those adverse effects. In order to do so, the EIS must reasonably identify maximum dissolved uranium concentrations that could be expected to enter ground water flow systems, and it should reasonably identify maximum flow rates in addition to a fixed flow rate at which contaminated water might enter those systems (such as that which could result from a rapid recharge event). Taken together, maximum concentrations and flow rates form a basis for establishing the outer limits of potential adverse impacts from uranium mining. For purposes of identifying maximum dissolved uranium concentrations that could enter ground water flow systems, the DEIS cannot rely on Liebe's (2003) Orphan mine samples. Although breccia pipe	NEPA does not require development of worst-case scenarios. The worst case analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618 (Apr. 25, 1986). CEQ Regulations require analysis of reasonably foreseeable impacts, not worst-case scenarios. Please refer to the response to comment 225279-19 (CBD and others) and EIS Section 4.4.1 (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells). As stated in EIS Section 3.4.4, subsurface conditions at the former and existing mine sites within the proposed withdrawal area are not favorable for the downward migration of leached minerals and other constituents from the mine openings. However, since

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			mining at the Orphan Mine has contaminated deep aquifers, it is unreasonable to assume that values recorded there represent a worst-case scenario for potential contamination that could result from future mining. The EIS should instead rely on maximum values measured in mine wells or sumps and assume, for the sake of a worst-case pollution scenario, that such water is able to enter the ground water system. USGS reported uranium concentrations at the Hermit mine sump far exceeding values recorded at Orphan Mine. The Hermit Mine sump concentrations ranged from 3,310 to 36,600 µg/L (the highest reported value of any sample type in this study) in 1989-90 (figs. 9A, 13). These high concentration mine shaft and sump waters may be sources of dissolved uranium for nearby sites if mine water is capable of entering the regional groundwater flow system. USGS hydrology report at 184. Thus, for purposes of a worst-case pollution scenario, and in order to best inform which alternative best serves the purpose and need of the proposed mineral withdrawal, the EIS should employ a maximum contamination value of 36,600 µg/L The DEIS assumes a constant flow rate of one gallon per minute from mines into deep aquifers. For purposes of defining a maximum flow rate, the EIS must evaluate a rapid recharge event moving through a contaminated mine sump and moving that water into the ground water flow system. In his 2008 testimony before Congress, Dr. Abe Springer described rapid recharge events: Although there are multiple and very deep (over 3,000 foot deep) aquifers in the vicinity of the Grand Canyon, recharge to these aquifers tends to be mostly focused and very rapid through faults, fractures, and sinkholes. Recharge to these deep aquifers can be on the order of hours and days, not weeks or years. The faults, fractures, and sinkholes can be pervasive and any enhancement of them can lead to enhanced recharge to the aquifer. Springer congressional testimony at 1. In addition to assuming a constant flow rate of one gallon per minute, the EIS should also anticipate the potential impacts of a rapid recharge event moving through a mined ore body and into regional ground water flow systems. The analysis should consider increases in uranium dissolution that would attend spikes in flows entering mined ore bodies that encounter oxidized uranium normally above water.	site specific conditions in future mine sites are not known, the uncertainty resulting from those conditions is addressed in the EIS with conservative assumptions. Therefore, the analysis of impacts in Section 4.4 assumes it is possible for some mine drainage to occur. The EIS identifies the reasonably foreseeable concentration in mine drainage reaching the R-aquifer as being the highest concentration detected from the R-aquifer at the Orphan Lode Mine (Section 4.4.1, Subsection Chemical Quality of Regional R-Aquifer Springs and Wells). Another conservative assumption used in the impact analyses is that there are no effects of attenuation and dilution of uranium and arsenic concentrations along the potential transport pathways. Please refer to EIS Section 3.4.4 for the existing data that indicate a constant inflow rate of 1 gpm is a conservatively high assumption. Because the assumed rate of 1 gpm used in the DEIS to project potential impacts to water quality in the R-aquifer is continuous, it more than accounts for instantaneous or short-term higher rates from storm events and overestimates longer-term lower rates during dry periods. There are no accounts of rapid recharge events flushing water through mined breccia pipe uranium deposits in the proposed withdrawal area. The permeability conditions that control groundwater recharge and groundwater movement in the regional aquifer, as well as flow to springs, are unlike conditions that control the location and preservation of economically viable breccia pipe uranium deposits. Overall, the methodology given in EIS Section 4.4.1 (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells) provides a conservative analysis of the impacts to the R-aquifer.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon	225279	21	Analysis of potential impacts to surface water quality at seeps, springs, creeks and caves should reflect a worst-case pollution scenario In the proposed withdrawal area, seeps and springs issue from fractures, bedding planes, or sandstone strata in perched aquifers in the Chinle, Moenkopi, Kaibab, and Toroweap formations, Coconino Sandstone, and Supai Group along the walls and channels of canyons or from outcrops on	NEPA does not require development of worst-case scenarios. The worst case analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618 (Apr. 25, 1986). CEQ Regulations require analysis of reasonably foreseeable impacts, not worst-case scenarios.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Chapter, Center for Biological Diversity			the plateaus. The DEIS acknowledges that uranium mining can drain and thus deplete perched aquifers that can feed seeps and springs. It also acknowledges that water from perched aquifers can move downward through breccia pipes and mined ore bodies. DEIS at 3-59. The DEIS also acknowledges that water feeding perched aquifers can travel laterally along confining rock layers. DEIS at 3-69. The DEIS further acknowledges that recharge can happen rapidly. DEIS at 3-69. Even though the DEIS acknowledges uranium mines drain perched aquifers, and even though the water recharging those aquifers can result from surface and ground water traveling long distances along confining layers (i.e., flash flood sinking into "swallow holes"), the DEIS applies small buffers around springs to assess potential impact zones. While the DEIS argues that its buffers are conservatively large (DEIS at 4-51), there is no evidence to indicate that those buffers are large enough or of an appropriate shape to capture the origin points of recharge water. For example, they are clearly not large enough to capture the spatial extent of watersheds from which "swallowed" flash floods could originate. Because we know that surface water and flash floods can recharge perched and deep aquifers, the DEIS should employ the boundaries of sub-watersheds within which springs occur as potential spring impact zones. (see comment #225279 for detailed DEIS Quotes.)	"Swallow holes" are typically located along structural features such as large fault zones (e.g., Markham Dam fracture zone on the Coconino Plateau) in combination with karstic or solution-enhanced features of the Kaibab Formation (see EIS Section 3.4.6, Subsection Recharge), which is a limestone unit present at land surface over much of the proposed withdrawal area. These combined features may provide nearly direct pathways that cut through perching layers to deep aquifer zones, including the R-aquifer, and represent hydrologic sinks for downward drainage of perched aquifer units. Perched aquifers are expected to be drained along these high permeability features. These conditions are very different from those that occur at economically viable breccia pipe uranium deposits or mines. EIS Sections 3.4.4 and 4.4.1 describe the small discharge from perched aquifers at these locations and how the discharge decreases rapidly; none of the accounts of mine drainage at former mines indicate anything more than slight, short-term increases, if any, of drainage to the mines from these zones in response to storm events. Mine operations would be seriously impeded by excessive inflow of water, but there are no accounts of such events occurring. Most accounts refer to how dry the conditions are in the mines. The EIS clearly states at many locations in Sections 3.4 and 4.4 that the perched aquifers are small, thin, and discontinuous. The conditions described in EIS Section 3.4.6 (Subsection Recharge) for perched aquifers limit the extent of the perched aquifers; Please refer to the response to comment 225279-7 (CBD and others) for further discussion of perched spring drainage areas.
Abe Springer	225286	1	The Supai Formation is a very leaky confining layer, hence the absence of many perched aquifers on top of it. The Supai Formation is not a barrier to downward leakage to the Redwall- Muav aquifer. In fact, if it was a very tight confining layer, there would be significant perched aquifers above it, and the Redwall-Muav aquifer wouldn't receive recharge. Because of the leaky nature of the Supai Formation and the extensive faulting and fracturing within the regional groundwater flow systems, recharge is actually very fast, but episodic. Recharge at sinkholes or along faults or	Where the Supai Group is not breached by faults and interconnected open fractures, or where these features have been filled and healed, the fine-grained units of the Group have low permeability and impede the downward of movement of water from overlying formations and upward movement of water from underlying formations. Pool and others (2011, page 25) states that "The Redwall-Muav aquifer is mostly

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			fractures can go from land surface to the Redwall-Muav within hours. A large storm event, which exceeds the capacity of retention basins around or adjacent to mining areas has the potential for rapid recharge to the deep regional aquifer. The EIS omits a significant discussion of the rapid, episodic nature of focused recharge to the Redwall-Muav aquifer. Therefore, the related analyses and assumptions about contaminant transport are flawed within the EIS. The rapid, episodic, and focused nature of recharge should be included in the EIS analyses.	confined by fine-grained sediments in the overlying Lower Supai Formation…" These conditions have been observed at breccia pipe uranium mines. Permeability measured for core samples of the breccia pipe and Supai Group at the Canyon Mine were very small (Canyon Mine APP, Montgomery 1993b as cited in the EIS) and fractures in the core were observed to be healed by cementation and fine-grained material. The DEIS adequately discusses the wide range of recharge conditions in Section 3.4.6 (Subsection Recharge); however, additional clarification is provided in this section in the FEIS. As described in EIS Section 3.4.4, rapid recharge of the R-aquifer is not an important mechanism at economically viable breccia pipe uranium mines due to the local hydrogeologic conditions. There are no accounts of rapid recharge through underground mine workings at breccia pipe uranium deposits even after significant storm water runoff at land surface. Rapid deep groundwater recharge could only represent a potential mechanism for transport of contaminants to the R-aquifer if the mine is located along an open fracture or fault system, which is unlikely because high-grade ore targeted for mining would not be preserved in such highly oxidizing conditions (see EIS Section 3.4.4). Also refer to the response to comments 225279-20 (CBD and others), 225279-21 (CBD and others), and 225280-13 (ASLD).
Abe Springer	225286	2	A significant "Water Resource Issue" is missing from the EIS, as listed in Table 3.1-1. This missing issue is the Contamination or loss of the Havasupai Nation water supply. For completeness in the analysis of the EIS, any water supplies which could be contaminated, such as the aquifer at Tusayan or the Colorado River, should be included in the analysis. The omission of the Havasupai Nation water supply is a critical omission. This issue should be specifically listed as a Water Resource Issue and should be analyzed in the EIS. This omission may be due to the fact that the EIS did not include all existing, relevant literature to conduct the analysis of the impacts to the water supply of the Havasupai, as expressed at Havasu Springs.	The Resource Category/Issues listed in Table 3.1-1 were derived from the public scoping process and include potential impacts to Havasu Creek. Impacts to the Colorado River and the groundwater system that feeds Havasu Creek are discussed in detail for each alternative in DEIS Section 4.4.
Abe Springer	225286	3	The EIS omits the peer reviewed publication of Crossey and others, 2009. This manuscript was published in the peerreviewed journal GSA Bulletin on April 24, 2009 and should have been used in the EIS analyses. The attached figure from this manuscript clearly shows the groundwater flow paths from the South Parcel to Havasu Springs. Crossey, L.J., K.E.	EIS Figure 3.4-14 (after Bills et al. 2010) is a conceptual diagram showing similar directions of groundwater movement in the R-aquifer system of the Coconino Plateau as the figure cited in this comment. The figure cited in this comment is actually based on

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Karlstrom, A.E. Springer, D. Newell, D.R. Hilton, T. Fischer. 2009. Degassing of mantle-derived CO2 and He from springs in the southern Colorado Plateau region neotectonic connections and implications for groundwater system, Geological Society of America Bulletin., 121:1034-1053, doi: 10.1130/B26394.1	work by Kessler (2002, Figure 26), which is cited in the EIS, and corroborates the conceptual model used in the EIS to project potential impacts. Figure 3.4-14 clearly shows that the direction of groundwater movement from most of the South Parcel is toward the Havasu Creek drainage and the associated text further discusses the hydrologic connection of this area with springs in Havasu Creek. In addition, Crossey et al. (2009) is cited in Bills et al. (2010), which is cited numerous times in the EIS.
Abe Springer	225286	4	The EIS omits another important publication, by Pool and others 2011. Although this was not published until April 2011, it was in draft form in review by December 2009 and could have been used for analysis in the EIS. I served as a member of a technical committee which advised the construction of this model and as a technical reviewer for the published report of the model. The second figure attached to this letter is the regional hydraulic head map from this model, which is more complete and accurate than Figures 3.4-14 and 3.4-15 in the EIS. Figure 3.4-15 is from a study published in 1974 and is very outdated. Figure 3.4-14 deliberately does not show flow arrows continuing from the South Parcel to Havasu Springs or to Blue Springs to give the perception of uncertainty in the directions and magnitude of groundwater flow. The directions and magnitude of flow are clearly shown on the attached figures from Crossey and others 2009 and Pool and others 2011. The authors of the EIS should have had the USGS conduct a flowpath analysis on the Northern Arizona Regional Groundwater flow model of Pool and others 2011, as is shown with the flow model published in Crossey and others 2009. The flow model of the USGS could be used to calculate travel times and velocities of groundwater. Pool, D.R., K.W. Blasch, J.B. Callegary, S.A. Leake, and L.F. Graser. 2011. Regional groundwater-flow model of the Redwall-Muav, Coconino, and alluvial basin aquifer systems of northern and central Arizona. U.S. Geological Survey Scientific Investigations Report 2010-5180, 101 p.	As indicated in this comment, Pool and others (2011) was not publicly available during the preparation of the DEIS. Pool and others (2011) is a USGS publication. The USGS indicates that its review and publication policy does not allow for the limited release of findings before publication. Pool and others (2011) has been considered for the FEIS; however, it does not change any of the EIS analyses. The regional flow model by Pool and others (2011) poorly represents conditions in the proposed withdrawal area and is not based on any new information that was not already accounted for in USGS SIR 2010-5025 to determine the hydrogeologic framework both north and south of the Colorado River. In addition to the lack of sufficient data for groundwater level, local flow paths, and locations of future mines, the calculation of travel times and velocities using the Pool and other (2011) model would not provide information that would improve the EIS analysis, remove any uncertainty, or change the conclusions. EIS Figure 3.4-14 presents a conceptual model that is similar to figures provided by commenter. In any event, groundwater flow arrows are at best general indications of flow direction, especially in flow systems dominated by fracture flow, such as the R-aquifer. It is widely accepted and acknowledged that Havasu springs is a regional drain for the R-aquifer south of the Colorado River. The impact analysis in the EIS assumes a connection between the South Parcel and both Havasu and Blue Springs, and these relations are clearly shown on Figure 3.4-14.
Abe Springer	225286	5	For the groundwater flow systems underlying the North and East parcels, regional flow models don't exist. But, both of these regions have well developed karst systems with sinkholes that extend from land surface to	Please refer to the responses to comments 225279-20 (CBD and others), 225279-21 (CBD and others), 225280-13 (ASLD), 225286-1 (A. Springer), and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the water table. Recharge through these sinkholes is rapid when conditions exist for runoff. Because of the rapid recharge to the aquifers of the regions in the North and East parcels and the lack of scientific tools to predict impacts from mining activities, it would be prudent to apply the precautionary principle and allow no mining till these tools are developed.	225286-4 (A. Springer). Sinkholes are karst features that have been observed in the Kaibab Formation. As described in EIS Section 3.4.6 (Subsection Recharge), open, extensive, interconnected vertical fractures and solution openings can convey recharge at some locations directly to the deep aquifer system. However, by definition, it is unlikely that the surficial sinkholes extend below the Kaibab Formation, and certainly not to either the perched water table in the Coconino Sandstone or the regional water table in the R-aquifer. As described in the responses to other comments cited above, such conditions have no relation to economically viable breccia pipe uranium deposits.
Abe Springer	225286	6	For the above stated reasons, the analyses in the EIS are not complete and are flawed. The tools and techniques used in the EIS do not represent the best available science to show the impacts of potential groundwater contamination from the South Parcel on Blue Springs or Havasu Springs. The simple dilution calculations in Chapter 4 of the EIS are not the best available science for conducting an impact analysis. The regional groundwater flow model of the USGS should be used to conduct a particle tracking analysis and potentially a contaminant transport model. The Havasupai rely upon water supplied from springs, not wells, so the water supply, as delivered by springs to the Havasupai, should be tracked and analyzed as a "Water Resource Issue".	The EIS use the best available science in its formulation. The EIS represents an exhaustive compilation of pertinent available data for the resources, citations for which can be found in Chapter 6. Please refer to the responses to comments 225286-1 through 225286-5 (A. Springer).
Patrick Hillard	225288	1	Some of the indicators of an investigator letting his anti-industry bias influence his findings are: Deliberate errors in logic, i.e. the conclusion not being supported by the information. An example of this is on page 4-85 of the EIS where the investigator states that elevated levels of arsenic in Miner’s Spring are due to the Grandview Mine. The only known connection between the mine and the spring is their proximity. There is no other evidence to indicate that the elevated arsenic is due to the mine. It is possible that the elevated arsenic is present because of the copper and associated mineralization independent of the mine, or that the arsenic originated from some source other than the mine.	Please see response to comment 225256-79 (ACERT).
Patrick Hillard	225288	7	Water consumption at a typical mine should be compared to water consumption at the South Rim, various cities in the surrounding area, and local industries.	This topic is discussed in the EIS Section 4.4.4 (Subsection Cumulative Impacts).
Maren Mahoney	226214	6	The EIS failed to take the required hard look to the threats to water quality and quantity. This is particularly crucial in our desert climate and our current multi-year drought, as well as expanding population.	Water quantity and quality have been thoroughly addressed in the EIS in Section 3.4 and Section 4.4.
Kay M. Hawklee	241505	1	1.Will a baseline of surface and groundwater quality be required prior to drilling? 2. Will the drillers be required to use a "closed-loop" fluid circulation system so that ground and surface water quality will be	Rules regarding drilling and abandonment of exploration wells are discussed in EIS Section 4.4.1 (Subsections Quantity of Discharge from Perched

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			protected from drill cuttings and core samples begin buried in pits? 3. If #1 is not followed, and BLM allows mud-circulation pits, will they be required to be lined? 4. What is the "Mil" strength that should be required for that liner? 5. What are the requirements for placement of that liner material; e.g. 2 feet overhang over the lip of the mud pit? (See the Michigan State requirements for good examples of pit requirements.) 6. What will be the bore-hole abandonment procedures that will protect cross-contamination down-hole during and after completion of the bore holes? 7. Will there be a requirement that the holes are filled with cement or bentonite? 8. Will all drill cuttings and core samples be required to be removed to a hazardous waste facility? 9. What is the source for water necessary for the drilling procedures? 10. Will water rights be granted for drilling? 11. Will downstream water rights be infringed upon?	Aquifer Springs and Wells — Wells). Water rights for groundwater are not required in the area of Arizona covered by the proposed withdrawal. This EIS is an analysis of a mineral withdrawal proposed by the Secretary of Interior and two alternative withdrawals. No specific mine operations are being addressed, nor will any be authorized as a result of this analysis. The description of mine inspections and other techniques (mitigations) to reduce environmental impacts and assure compliance to laws and regulations would be established at the time of site-specific NEPA analysis of any new Mine Plan of Operations.
Central Arizona Project	242648	2	The DEIS for the Northern Arizona Proposed Withdrawal Project indicates that all of the alternatives evaluated would result in a negligible increase in uranium concentrations in the Colorado River over historical background levels. It should be noted, however, that the effects of increased mining within the subject area may affect consumer confidence over the safety and reliability of the Colorado River for its use as a municipal drinking water supply, irrespective of any definitive public health impacts. Considering the tragic aftermath of the recent earthquake and tsunami in Japan, the public has a heightened concern over the potential for even minute amounts of radiation in water supplies. As such, it is critical that a comprehensive water quality monitoring program be in place to inform stakeholders and ensure long-term protection of the Colorado River from threats of uranium and other regulated constituents impacted by mining operations for all alternatives being investigated.	Public perception is subject to many real or perceived conditions and analysis of such would be speculative in an EIS. The purpose of the EIS is to analyze the effects of the Proposed Action and Alternatives, which is mineral withdrawal from the Mining Law of 1872 subject to valid existing rights. Appropriate mitigation for mining would be developed when site-specific NEPA analysis is undertaken for a particular mine proposal. State and Federal agency experts are currently reviewing various mitigation measures, Best Management Practices, and monitoring that could potentially be considered as part of these site-specific analyses and, if appropriate, could be considered for incorporation into relevant land use plans.
Central Arizona Project	242648	4	Exploration and mining within the subject area may also lead to increased erosion and sediment loading along the tributaries to the Colorado River, potentially affecting salinity levels. CAP, Metropolitan, and SNWA participate on the Colorado River Basin Salinity Control Forum and are committed to efforts to control salinity inputs along the Colorado River. We request that the Final EIS clearly identify the potential impacts of large-scale exploration and mining activities in the subject area on salinity loading to the Colorado River.	This issue is discussed in the cumulative impact analysis for Alternative A, No Withdrawal in the EIS Section 4.4.4 (Subsection Cumulative Impacts) for surface water and Section 4.5.3 (Subsection Cumulative Impacts) for soils. Reasonably foreseeable uranium mining in the withdrawal area is not anticipated to result in large increases in sediment loads in stream channels. The total area of temporary surface disturbance anticipated under Alternative A is 1,364 acres out of the total proposed withdrawal of about 1 million acres (Table 2.7-3).
Central Arizona Project	242648	5	It is not clear whether the DEIS evaluated worst-case scenarios for each of the alternatives should the mitigation measures designed to prevent downstream transport of uranium-bearing material fail. Given the uncertainty in the location and number of mines to be operated under each	NEPA does not require a worst-case scenario analysis (this analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618, Apr. 25, 1986), only analysis of circumstances that are reasonably foreseeable is

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			alternative, the Partnership requests that worst-case scenarios be fully evaluated in the Final EIS in terms of the water quality effects on the Colorado River and its tributaries.	required. Appendix B provides this reasonably foreseeable development scenario and provides a rationale to why this scenario is used.
Arizona Rock Products Association	242654	11	The DEIS goes to great length to discuss the existing and potential impacts from mining to both surface and groundwater quality and quantity. Unfortunately, the DEIS appears to bias the results of the analysis by favoring unrealistic or unsubstantiated assumptions when quantifying the Environmental Consequences. Hundreds of mineralized pipes exposed within the canyon are gradually eroding, oxidizing and leaching uranium into the environment. In fact, the USGS and AGS note that the amount of uranium naturally eroding into the watershed from these exposed breccia pipes far exceeds any past releases of uranium from historic mining releases in addition to any reasonably-anticipated releases of uranium from future mining activity. Consequently, any withdrawal based on the assumption that the cessation or prevention of uranium mining activity will somehow preclude the introduction of uranium into the Grand Canyon watershed is seriously flawed.	Please refer to response to comment 225266-7 (AZ Mining Assoc.) and 225280-13 (ASLD).
Arizona Rock Products Association	242654	12	With regards to groundwater impacts ' occurring from recent (modern) and future anticipated mining, the DEIS describes in 3.4.4 that several regulatory and independent consultant reports indicated that conditions are not favorable for migration of leached minerals and regulated constituents from modem mining operations to regional aquifer systems. Further, there is little evidence that the impact of mine well pumping could ever impact any regional wells.	Potential impacts to the R-aquifer from projected pumping from mine supply wells and mine drainage are addressed for each alternative in EIS Sections 4.4.4 through 4.4.7.
Arizona Rock Products Association	242654	13	the DEIS assumes that these discharges will migrate more than 1,000 feet (the average distance between modern breccia pipe mining operations and the regional aquifer system) through low permeability sedimentary units and subsequently discharge into the regional aquifer/springs with no dilution or dispersion. Why does the DEIS fail to use standard industry hydraulic and geochemical models to accurately measure the water-rock and water-water interactions that occur as a discharge moves through the vadose zone, encounters and mixes with groundwater and moves laterally through the aquifer to a downgradient point of compliance or discharge?	The EIS represents an exhaustive compilation of pertinent available data for the resources. Many assumptions are required for a contaminant transport model. Because no data are available for most of the proposed withdrawal area, the modeling exercise proposed in this comment would not necessarily provide better results than the conceptual method used in the EIS or remove the uncertainties. The parameters used in the impact projections were based on reasonable assumptions and developed from existing data. For discussion of why impacts from the Orphan Lode Mine were used to characterize possible impacts in the proposed withdrawal area, refer to response to comment 225256-32 (ACERT).
Arizona Rock Products	242654	14	Because the DEIS is charged with scientifically evaluating possible Environmental Consequences, it seems irresponsible to use arbitrarily	The EIS represents an exhaustive compilation of pertinent available data for the resources. Many

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Association			selected discharge volumes, constituent concentrations and downstream impacts that are derived from data that is clearly not representative of modem mining conditions and could easily be more accurately predicted if the process employed scientifically-based and defensible groundwater and geochemical models.	assumptions are required for a contaminant transport model. Because no data are available for most of the proposed withdrawal area, the modeling exercise proposed in this comment would not necessarily provide better results than the conceptual method used in the EIS or remove the uncertainties. The parameters used in the impact projections were based on reasonable assumptions and developed from existing data.
Arizona Rock Products Association	242654	17	Although there has been no incident in the 30-year history of modem breccia pipe development that would appear to justify a withdrawal, the DEIS purposefully biases the Environmental Consequences and the RFD by using pre-reclamation environmental data from the Orphan Mine which was originally developed in 1947. Even though the DEIS states that the conditions evaluated are not accurately determined and are contrived from data that is clearly not representative of modem mining conditions, the DEIS consistently fails to use scientifically-based and defensible groundwater and geochemical models to estimate potential impacts to the environment.	For discussion of why impacts from the Orphan Lode Mine were used to characterize possible impacts in the proposed withdrawal area, refer to response to comment 225256-32 (ACERT).
Quaterra Resources, Inc.	242664	8	The DEIS is strangely silent on a number of issues germane to a decision on whether to withdraw these lands from mineral exploration and development, and more importantly would give an uninformed reader a sense of perspective and balance. These issues include 3) the safe and successful exploration, mining and reclamation of seven pipes by Energy Fuels from 1980-1989 which demonstrated conclusively that uranium mining does not represent a threat to the environment.	The legacy mining of the 1980s and known associated impacts are discussed in EIS Sections 3.4.4 and 3.5.4 (Subsection Effects from Historic (1980s) Mining). Typical reclamation practices at 1980s mine sites are discussed in EIS Section 4.5.2.
Quaterra Resources, Inc.	242664	16	Although there has been no incident in the 30-year history of modem breccia pipe development that would appear to justify a withdrawal, the DEIS purposefully biases the Environmental Consequences and the RFD by using pre-reclamation environmental data from the Orphan Mine which was originally developed in 1947. Even though the DEIS states that the conditions evaluated are not accurately determined and are contrived from data that is clearly not representative of modem mining conditions, the DEIS consistently fails to use scientifically-based and defensible groundwater and geochemical models to estimate potential impacts to the environment.	Please refer to the responses to comments 225256-32 (ACERT) regarding the use of the Orphan Mine to estimate potential impacts to the R-aquifer. Regarding groundwater modeling, please refer to the responses to comments 242654-13, 14, and 17 (AZ Rock Prod. Assoc.) and 225286-4 (A. Springer) regarding the use of numerical or geochemical models.
Quaterra Resources, Inc.	242664	22	In Subsection B.4.1, the DEIS notes that the first breccia pipes were originally discovered as a result of their exposures in the walls of the canyons. While there are literally hundreds of exposed pipes along the canyon, the DEIS goes to great lengths to avoid a discussion of how many exposed pipes are naturally releasing uranium into the Colorado River watershed. Many mineralized pipes exposed within the canyon have become (or are gradually becoming) barren due to the slow erosion,	Please refer to responses to comments 225266-7 (AZ Mining Assoc.); 242654-13, 14, and 17 (AZ Rock Prod. Assoc.); 225280-13 (ASLD); and 225256-32 (ACERT). The EIS acknowledges the extensive framework of existing regulations applicable to hard-rock mining in the area (see Chapter 1, Section 1.4.3, Authorities,

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			oxidation and leaching of the mineralized rock. In fact, the Arizona Geological Survey (AGS) did a recent study of this, which found that the amount of uranium naturally eroding into the watershed from these exposed breccia pipes far exceeds any past releases of uranium from historic mining releases as well as all anticipated releases of uranium from future mining activity. However, some data collected near legacy mining operations (page 3-85) do suggest that some localized groundwater impacts have occurred. But, these historic mining operations had clearly operated and closed prior to the promulgation of rigid state and federal regulations protecting surface and groundwater quality. By contrast, the principal conclusion of the 2010 USGS report on groundwater quality (Section 3.4.7) was that: Observation of groundwater-chemistry relation between concentration and mining condition were limited and inconclusiveAlthough there has been no incident in the 30-year history of modem breccia pipe development that would appear to justify a withdrawal, the DEIS purposefully biases the Environmental Consequences and the RFD by using pre-reclamation environmental data from the Orphan Mine which was originally developed in 1947. Even though the DEIS states that the conditions evaluated are not accurately determined and are contrived from data that is clearly not representative of modem mining conditions, the DEIS consistently fails to use scientifically-based and defensible groundwater and geochemical models to estimate potential impacts to the environment. If this is the case, any withdrawal based on the preposition that the cessation or prevention of uranium mining activity will somehow preclude the introduction of uranium into the Grand Canyon watershed is seriously flawed.	and Appendix B, Reasonably Foreseeable Development Scenarios, Section B.3, Regulatory Framework). However, the purpose and need for the action, as stated in Chapter 1, Section 1.3, is not altered by the fact these regulatory controls are in place.
Quaterra Resources, Inc.	242664	23, 24, 25 & 26	The DEIS characterizes the R-aquifer as potentially the most prolific aquifer in the region. Generally, more than 2,000 feet below land surface, the R-aquifer occurs in gently folded limestone and dolomite units. Because of the relative depth and uncertainty of encountering productive zones within the R-aquifer, the DEIS reports that: *Records indicate that no non-commercial or non-industrial entities have installed R-aquifer wells…even though the R-aquifer is recognized as the most reliable source of groundwater.* The DEIS clearly states on pages 4-48 and 4-48 as well as Section 3.4 (reference Figure 3.4-14) *that for many potential mines located in the North Parcel, there could be little to no impact to the R-aquifer and no impact to the Grand Canyon Watershed.* Specifically: *R-aquifer groundwater along the western, northwestern and northeastern margins of the North Parcel is likely to move to the north toward areas in south and central Utah. The R-aquifer dips deeply northward from near the Grand Canyon to thousands of feet in depth (see Figure 3.4-4) and does not directly feed springs along the Virgin River*and *Only oil and gas wells are known to penetrate to these depths in Utah, where the R-aquifer is not considered a viable drinking water supply.*Similar areas in the East and South Parcels are noted in the DEIS on pages 4-48 and 4-49 where fault	Please see the response to comment 225269-3 (ADEQ) regarding the assumption of 1 gpm. Please see the response to comment 225260-29 (EFR) regarding the assumption of the number of mines that may contribute drainage to the R-aquifer. Please see the response to comment 225260-24 (EFR) regarding the use of data from Horn Creek to project impacts from mine drainage. Please see the responses to comments 242654-13, 14, and 17 (AZ Rock Prod. Assoc.) and 225286-4 (A. Springer) regarding the use of numerical and geochemical models.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			zones, geologic structure and regional flow prohibit possible mining impacts to the R-aquifer and in some cases local seeps and springs from impacting the Withdrawal area. With regards to groundwater impacts occurring from recent (modern) and future anticipated mining, the DEIS describes in 3.4.4 on pages 3-57 and 3-58 that several regulatory and independent consultant reports indicated that: *Modern (post 1980) breccia pipe uranium mine sites in the study area (emphasis added) are generally characterized by well-cemented, very low permeability breccias and adjacent formation rocks, which do not permit the flow of groundwater through the tightly-locked mineral deposits. This condition inhibits dissolution of mineral deposits associated with these economically viable breccia pipes into groundwater. In each case, these ore deposits are on the order of 1,000 feet or more above the R-aquifer system and are underlain by the poorly permeable breccias and siltstones/mudstones of the Hermit Formation and Supai Group. Therefore (emphasis added), conditions are not favorable for downward migration of leached minerals and constituents (such as uranium and arsenic) from the ore deposits to the R-aquifer.On page 4-60, the DEIS also concludes: It is also important to recognize that, based on the information described in Section 3.4, there is currently no conclusive evidence from well and spring sampling data that (modern) breccia pipe uranium operations in the north Parcel have impacted the chemical quality of groundwater in the regional R-aquifer. And, also on page 4-60: the low permeability conditions associated with ore deposits in the breccia pipes and adjacent rock strata between the base of mine openings and the Raquifer are thought to retard the downward movement of any perched groundwater drainage into the mines and, therefore, are not favorable for downward migration of dissolved minerals from the mine openings.*	
Quaterra Resources, Inc.	242664	23, 24, 25 & 26	Continued...With regards to potential impacts to the quantity of water in the regional R-aquifer based on the average mine withdrawal rate of 5 gpm, the DEIS states on page 4-59 that: drawdown was projected for a well pumping 5 gpm continuously for 5 years. Results indicate that the 5-foot water level drawdown contour could extend about 270 feet from the mine well in relatively unfractured aquifer areas and much less than 1 foot from the well in major fault zones. Further, regarding impacts to surrounding wells or water resources, the DEIS reports on page 4-59 that: Based on the location of existing wells and the projected construction of new (mine) wells, it is not likely that mines would be located sufficiently near a nonmine R-aquifer water supply well to cause more than negligible water level drawdown impact to the non-mine well. In other words, assuming that all mine wells would be located within their respective 20- acre mine site, the R-aquifer is so productive that the maximum drawdown of mine well pumping could never impact any non-mine wells because the actual drawdown from these mine wells would be entirely located within the mine footprint. There are several consolidated and unconsolidated perched	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			aquifer systems discussed in the DEIS. These systems are individually discussed on pages 3-42 and 3-44 but are uniformly defined as: temporary perched aquifer zones may occur such perched groundwater zones are thin and discontinuous and are generally ephemeral; the stored water is gradually lost via evapotranspiration and slow downward seepage. Yet, despite these earlier descriptions, the DEIS fabricates a perched groundwater flow model that simulates long-term continuous 1-gpm drainage from half of the mines projected in the RFD even though the DEIS clearly concludes: A long term continuous groundwater discharge of 1 gpm from the perched aquifer system penetrated by mine openings would exceed the conditions historically encountered in the existing and reclaimed breccia pipe mines on the North parcel (see Section 3.4). Further, most of the perched aquifer springs that have been measured or estimated on the North, East and South parcels discharge 1 gpm or less.The significance of this model assumption doesn't become apparent until the DEIS discusses the potential for perched water to become impacted by future mining operations on page 3-59 and goes on the state: At the breccia pipe uranium mines in the study area, perched water zones, if present (typically above the Hermit Shale basal confining unit) are small, thin and discontinuous. Water yield to mine openings from these perched zones typically decreases over the first few months to 2 years on mining, from several gallons per minute to no measurable flow.	
Quaterra Resources, Inc.	242664	23, 24, 25 & 26	Continued... The DEIS goes on to conclude on pages 3-59 and 3-60:Therefore, movement of perched water away from the mine openings is not anticipated to occur during mine operations. Based on these facts, the apparent risk to either groundwater flow or quality to the regional R-aquifer or seeps and springs fed by the R-aquifer would appear to be negligible. However, the DEIS reaches deep into the realm of the hypothetical on page 4-60 by assuming that half of all potential mines in the study area would encounter perched water systems capable of continuous discharge. In the most flagrant mischaracterization found in Chapter 4, the DEIS estimates that the potential drainage from 50% of the mines considered in the RFD would contain dissolved uranium concentrations of up to 440 ug/L (See Appendix F) when these discharges reach the R-aquifer. They continue with this assumption even though the DEIS notes that the 400 ug/L value is: The highest concentration detected in water samples obtained directly below the (Historic) Orphan Lode Mine (Liebe 2003). Even though the near-rim and unreclaimed conditions at the Orphan Lode Mine are not considered to be comparable to conditions at existing or historic breccia pipe mines	
Quaterra Resources, Inc.	242664	23, 24, 25 & 26	*Continued:* Additionally: None of the studies conducted for water quality at the R-aquifer mine wells on the North Parcel, one of which included periodic sampling for up to 9 years after the completion of mining (Hermit Mine well), concluded that uranium mining activities have affected the R-	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			aquifer. Regardless of the fact that the DEIS itself acknowledges the shortcomings of the data, the DEIS continues to rely on the mine drainage data collected from the legacy Orphan Lode Mine operation prior to reclamation. As previously stated for uranium, Section 4 of the DEIS (page 4-61) also goes on to assume that the maximum arsenic value (90 ug/L) detected at the un-reclaimed Orphan Lode Mine would somehow be representative of modern breccia piped mining conducted outside the canyon. These values represent arsenic and uranium concentrations that are approximately 10 times the maximum EPA values for drinking water. Remarkably, the DEIS also assumes: The potential mine drainage is not affected by attenuation or dilution during its migration through thousands of feet of sedimentary rock or miles of aquifer and is only modified by instantaneous mixing with the volume of water discharging at the Raquifer spring system for the basin analyzed. In a profound understatement of facts, on page 4-61 the DEIS concludes: This assumption would tend to provide resultant concentrations that are conservatively high; however, sufficient data are not available to characterize flow paths and dilution rates in the R-aquifer from future mines. In Arizona, Aquifer Protection Permitting (APP) routinely requires the applicant to estimate the concentration and flow of any potential discharges to be permitted. The applicants are not required to use the maximum concentration values of any potential contaminant of concern unless that concentration value is representative of the actual (measured or estimated) discharge condition. Further, the impact of water quality from these discharges can be accurately measured with credible hydraulic and geochemical models that can accurately measure the water-rock and water-water interactions that occur as a discharge moves through the vadose zone, encounters and mixes with groundwater and moves laterally through the aquifer to a downgradient point of compliance or discharge. Considering that the stated reason for conducting the DEIS was to scientifically evaluate concerns of potential impacts to the Grand Canyon watershed from future uranium mining, it seems irresponsible to use arbitrarily selected discharge volumes, constituent concentrations and downstream impacts that are derived from data that is clearly not representative of modern mining conditions and could easily be more accurately modeled if the process employed scientifically-based and defensible groundwater and geochemical models.	
Quaterra Resources, Inc.	242664	42	Chapter 4 does not analyze the issue of naturally occurring uranium contamination in the Grand Canyon Park with regards to natural sources of uranium contamination from ore-grade breccia pipes that are currently eroding within the Canyon and where the uranium is being transported into the Colorado river. There are approximately 30 such ore-grade breccia pipes that are naturally exposed in the Grand Canyon in which the ore body is being eroded by wind and water. These natural sources of uranium contamination should be discussed in Chapter 3 and analyzed in Chapter	Please refer to the response to comment 242913-27 (NAU Project), as the content is identical to this comment.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			4. The effects from these natural breccia pipe contamination sources on the Grand Canyon water and ecosystems should be analyzed and compared to the possible contamination contribution of the projected uranium mines determined in Appendix B to determine what the cumulative effect the projected mines might have. The BLM should have undertaken this particular research and analysis along with the Park Service at the beginning of this DEIS process in order to determine the cumulative effects of proposed uranium mining outside the GCNP and the naturally occurring source of uranium contamination (eroding ore-grade breccia pipes) on the park itself. The NEPA process requires that this type of information be gathered and analyzed if the costs are not prohibitive. This research should be conducted and the cumulative effects analyzed as required by NEPA and a supplemental DEIS published for comment.	
The NAU Project, LLC	242913	15	Page ES-12 Water Resources This section of this DEIS is inadequate and needs a total rewrite. Most of the assumptions are absurd and the conceptual modeling and analysis is biased toward creating "major impact" determinations. More disclosure of the actual calculations made and the specific data sets used is in order. A separate appendix for these would be appropriate.	EIS Section 4.4.1 provides detailed example calculations. Actual calculations are included in the project file for the EIS and are available upon request.
The NAU Project, LLC	242913	27	Chapter 3 does not address the issue of the current state of the Grand Canyon Park with regards to natural sources of uranium contamination from ore-grade breccia pipes that are currently eroding within the Canyon and where the uranium is being transported into the Colorado river. There are approximately 30 such ore-grade breccia pipes that are naturally exposed in the Grand Canyon in which the ore body is being eroded by wind and water. These natural source of uranium contamination should be discussed in Chapter 3 and analyzed in Chapter 4. The effects from these natural breccia pipe contamination sources on the Grand Canyon water and ecosystems should be analyzed and compared to the possible contamination contribution of the projected uranium mines determined in Appendix B to determine what the cumulative effect the projected mines might have. The BLM should have undertaken this particular research and analysis along with the Park Service at the beginning of this DEIS process in order to determine the cumulative effects of proposed uranium mining outside the GCNP and the naturally occurring source of uranium contamination (eroding ore-grade breccia pipes) on the park itself. The NEPA process requires that this type of information be gathered and analyzed if the costs are not prohibitive. This research should be conducted and the cumulative effects analyzed as required by NEPA and a supplemental DEIS published for comment.	The FEIS contains an expanded discussion of the range of potential hydrogeologic conditions at breccia pipes in Section 3.4.4, including breccia pipes that are exposed. Please refer to the response to comment 225280-13 (ASLD) for a detailed discussion of these conditions. Natural sources of uranium that might exist in the region represent a contribution to ambient conditions, and thus, should not be analyzed separately as a potential cumulative impact in Chapter 4. Because the EIS contains an exhaustive compilation of water sample data for the region in Appendices D through G, which is summarized in Section 3.4.7, the contribution from these natural sources of uranium are reflected in the EIS and its impact analysis in Section 4.4.4.
The NAU Project, LLC	242913	48	Page 4-51 Item number 6 of the method for groundwater drainage area for a perched aquifer spring: 6. Because the directional orientation of the assumed local fracture system is not known, all directions of the compass were addressed by **drawing a circle with a radius equal to the**	The buffer areas were not utilized in the calculation of impact probability. Rather, the buffer areas were used in development of the alternative withdrawal areas (Alternatives C and D). Text in DEIS Section 4.4.1

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			calculated length of groundwater drainage area, centered on each spring. This circle establishes the estimated potential impact area around each of the perched aquifer springs. It was assumed that mine sites within this radius of the springs might impact the quantity of discharge from the springs. **Using a circle with a diameter equal to the largest dimension of the rectangle** described above results in a **calculated area 7.8 times the actual area of the rectangle**; therefore, the area of potential impact is overestimated by the same amount. An exception is where the circle includes areas where the perched aquifer does not occur, such as beyond canyon walls that completely cut the aquifer. The two bolded parts of this paragraph are incompatible. For example, based on the 1 gpm perched spring aquifer, the groundwater drainage area is .2 sqmi and the elongated drainage length is 1.4 mi. The estimate potential impact area is a circle whose radius is a line 1.4 miles long for which one of its end points is centered on the spring. Thus the diameter of the circle is 2.8miles and the midpoint of the diameter is centered on the spring. All the figures that show the estimated potential impact area show a 2.8 mile diameter for the 1 gpm perched aquifer spring. Thusly, the expansion of area from the calculated groundwater drainage area to the potential impact area is ~30 times and not 7.8 as was described above. This is an understatement of 384%. The actual over-estimation is more than 30 times the actual area of the rectangle. Soooo, Now I am not so sure that your binomial distribution formula was used correctly as you did not show your work. Please add an appendix and do so! Also, I think that you should show two different probabilities, one is the potential impact probability as described and the other is a probability based on the calculated perched spring drainage area itself. The fact that you don't know the orientation of the ground water drainage area at this time does not mean that they are unknowable. They are, for the most part, fixed, and any proposed mine would have to determine if it is located in a perched aquifer drainage area (including the orientation and extent) and address that in its Individual EIS before a Plan of Operations would be approved and a mine permit issued. The area of the perched spring drainage may be unknown, but it is not random. I think this may make a difference in probability theory and calculation. For random events, the probability is based on multiplying the randomness of each event by the other random events. I think that there is a lot of probability inflation going on. In other words, the method that you have chosen to calculate the potential impact area has exponentially increased the impact probability and greatly exaggerates the potential impacts. I think a comparison between the two calculated areas and the calculated impact probabilities is in order.	(Subsection Quantity of Discharge from Perched Aquifer Springs and Wells, Springs) on pages 4-51 and 4-52 indicating that buffer areas were used for calculating probability of impact is incorrect. The FEIS has been revised in Section 4.4.1 to correct this error. An example calculation for the binomial distribution formula is also provided.
The NAU Project, LLC	242913	49	Page 4-60 It is important to acknowledge that the travel time for some impacts to wells and springs may be longer than the time that has passed since uranium mining began in the North Parcel. Longer is rather vague in its usage here. The residence times for the majority of the withdrawal	Figure 26 cited in this comment depicts theoretical age of water samples, not necessarily the retention time in the R-aquifer and definitely not the travel time to springs. Such age dating studies are fraught with

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			areas is on the order thousands of years. For most mines, that would mean any affect that they might have on the other wells and springs could be, if detectable at all, undetectable for thousands of years into the future. The Retention Time Figure was taken from Figure 26 of the DIR Inc. Draft EA page 104 and modified to show the withdrawal boundary for the Southern Parcel. The contour lines were plotted from data in tables from USGS reports SIR2005-5222 and SIR 2004-5146. The Southern parcel is used as an example to illustrate my comments. As can be seen from the figure, the retention times in the southern withdrawal area range from about 5000 to 12000 years. This indicates that the transport time from the Raquifer in the southern parcel to springs at the Havasu and Blue Spring complexes is a very "long" time. Please clarify what a "Long Time" is. * **see submittal #242913 for detailed figure information**	uncertainty related to mixing of waters from various sources. Some groundwater in the R-aquifer moves very slowly and some moves rapidly, some is from recent recharge and some slowly seeps from pore spaces and poorly connected fractures in the rock. DEIS and FEIS Section 3.4.6 (Subsection Groundwater Occurrence and Movement in the R-Aquifer) contains a detailed description of groundwater movement in the R-aquifer. Water sampled at any one point in the aquifer reflects an age that is a composite of possibly multiple ages, some very recent. It makes sense that the theoretical age of groundwater nearer the discharge area of the aquifer (nearer the canyons) is less because that water has had much more opportunity to mix with more recent recharge along faults and fracture systems as it moved from the upgradient parts of the groundwater sub-basin toward the springs. The comment is correct that it might take as many as thousands of years for mine drainage to reach the R-aquifer at economically feasible breccia pipe uranium deposits and move toward springs, but the uncertainty of conditions over the entire proposed withdrawal area requires the conceptual model to allow for faster travel times. Recharge and movement of groundwater in other areas that are more fractured can be relatively rapid and these areas may comprise part of the pathway that mine drainage would take to points of groundwater discharge. It is likely that the route for contaminant transport would be composed of multiple segments having different travel times within the aquifer.
The NAU Project, LLC	242913	50	Page 4-60 These conditions result in low risk of impacts to the R-aquifer and support the assumption that it is entirely possible for there to be no impact to R-aquifer water quality. If an impact were to occur, the potential magnitude is addressed by the methodology and assumptions given below. The methodology and the assumptions made to measure the magnitude of the impact are faulty and don't conform to the requirements of NEPA.	The EIS describes existing conditions that are not favorable for mine drainage to occur to the R-aquifer from economically viable breccia pipe uranium deposits (Section 3.4.4). However, uncertainties require that conservative assumptions be made and that the reasonably foreseeable impact include more than the possibility of no impact. These two concepts necessarily may generate projected potential impacts that seem to be contradictory to the description of existing conditions. Please refer to the response to comment 225260-29 (EFR) for more discussion.
The NAU Project, LLC	242913	51, 52, & 53	Page 4-60 Second Paragraph The methodology and assumptions used to determine impact risk is based on the work of a graduate student (Liebe	These comments were very thorough and require multi-part responses, many of which have already

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			2003) and the measurements of uranium and its isotope activities at Horn Creek. The Liebe Master's Thesis is not available on the internet and a reviewer would have to go to NAU library to find a copy of it. It would have been nice if the major document cited for developing the assessment technique had been made available on the internet. However, the Appendix G analysis uses both the Fitzgerald data and the Liebe data and they are in agreement with regards to the U234/U238 Activity Ratio at Horn Creek. The AR for Salt Creek (if one is available) from the Liebe study was omitted in Appendix G. The Liebe data for uranium concentrations are the highest documented by some 1000% above what other credible researchers have found in this area. This leads to the conclusion that the Liebe data set was obtained quite differently than other researchers doing similar work. I obtained by email, a copy of the Fitzgerald thesis and noted that the sample locations for Horn Creek are all taken from the alluvium in the Horn Creek drainage basin. (The sample location data for Fitzgerald is shown on the next page.) The comments for Horn Creek place the sample locations where water, issuing from the Bright Angle shale - Muav limestone, would have flowed through the alluvium in the Horn Creek basin to the collection points. The Salt Creek sample location appears to be from a seep in the Tapeats Sandstone below the issue of the spring at bedding planes in the Muav Limestone. The water thus flows through the channel alluvium to the collection point for Salt Creek as well. From the SIR 2004-5146 a description of the sample locations for Salt and Horn Creeks are as follows: Salt Creek Spring. "Salt Creek Spring is at a headwall in the main Salt Creek drainage about 800 m upstream from the Tonto Trail crossing (pl. 1). Water discharges from bedding planes in the Muav Limestone and drips down an 8-m high cliff face of Muav Limestone onto a small talus slope on the west side of the canyon. The point of issuance of water is inaccessible; therefore, water samples were collected at the talus slope using a Visqueen sheet to funnel the flow into a Teflon holding bottle. All water enters the channel alluvium immediately downstream from the talus slope. During all site visits there was no evidence of flowing water in the stream channel from the talus slope to the Tonto Trail crossing. Discharge was measured where water flows over exposed Tapeats Sandstone (fig. 2) surfaces near the Tonto Trail (pl. 1). Water flows intermittently downstream from the Tonto Trail crossing to the Colorado River. No large-scale geologic structures have been identified near the spring. Recent flooding has removed large vegetation from the Salt Creek drainage. Horn Creek." Horn Creek consists of two primary branches.	been provided in response to comments by others. For a detailed response regarding the use of Liebe (2003) data in the EIS analysis of projected potential impacts, please refer to the response to comment 225260-24 (EFR). The permeability of the ring fractures at economically viable breccia pipe uranium deposits in the proposed withdrawal area is addressed in EIS Section 3.4.4. The EIS describes existing conditions that are not favorable for mine drainage to occur to the R-aquifer from economically viable breccia pipe uranium deposits in Section 3.4.4. However, uncertainties require that conservative assumptions be made and that the reasonably foreseeable impact include more than the possibility of no impact than zero. These two concepts necessarily may generate projected potential impacts that seem to be contradictory to the description of existing conditions. Please refer to the response to comment 225260-29 (EFR) regarding this issue. Regarding references in the comment to age of the groundwater, please refer to the response to comment 242913-49 (NAU Project). Regarding groundwater modeling, please refer to the responses to comments 242654-13, 14, and 17 (AZ Rock Prod. Assoc.) and 225286-4 (A. Springer) regarding the use of numerical or geochemical models. In response to comment 242913-55 (NAU Project) and 242913-56 (NAU Project), it is important to emphasize that all of the analyses for projected potential impacts to the R-aquifer include the potential for no or negligible impact to water resources (see Table 4.4-3). Many alternative contaminant pathway scenarios can be contemplated making different assumptions; however, the assumptions made for the EIS account for a wide range of pathways and flow mechanisms resulting in a wide range of projected potential impacts. The methodology offered in this comment simply is a subset within the range of conditions accounted for in the EIS, but this subset neglects the conditions that

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				could result in the higher end potential impacts described in the EIS. Regarding the difference in uranium concentrations detected along Horn Creek: It is entirely possible, and even suspected by Liebe, that downstream water sampling locations on Horn Creek ("Horn east alluvium" and/or the USGS sites) may not have the same source as the "Horn up" location where the 400 ug/L uranium was detected. Liebe based his interpretation on differences in general water chemistry, including sulfur content, and structural features. Nevertheless, significant dilution/attenuation appears to have occurred after only 100 feet of flow downstream from Liebe's "Horn up" site to his "Horn down" site (reduction from 400 ug/L to 322 ug/L). Liebe (2003) did not include water sample results from the Salk Creek drainage. For a discussion of uranium detected in Salt Creek, please refer to response for 96015-1 (D. Lipmanson).
The NAU Project, LLC	242913		Continued...The west branch is usually dry, and the east branch has perennial flow in places. The sample site is in the east tributary about 500 m upstream from the Tonto Trail crossing (pl. 1) where water discharges from the channel alluvium that overlies the Bright Angel Shale (fig. 2). Water samples were collected at a small waterfall that was formed by boulders in the stream channel. Discharge was measured volumetrically at a small waterfall near the sample site. The spring flow emerges on the downthrown side of the northwest-striking Salt Fault (pl. 1) and flows intermittently to the Colorado River. At the head of the drainage is a breccia pipe and a historic uranium mine. Recent flooding has removed most of the vegetation at the site, leaving a few Fremont cottonwood trees in the nearby channel reach. Appendix G and the analysis on page 4-60 both contend that the AR calculated for Horn Creek indicate an anthropogenic cause, i.e., that water has entered the Orphan mine and mobilized uranium into solution and has gone through the intervening rock units and is causing the high levels of uranium in the waters in Horn Creek. While this conclusion may be true, there is an equally and more plausible explanation for the higher uranium content in Horn Creek and also satisfies the noted AR of ~ 1 calculated for Horn Creek. A diagram of the Orphan mine is shown below and will help demonstrate my proposition. My basic argument is that a great deal of the ore bearing zone from the Orphan pipe collapsed/eroded from the wall of the Grand Canyon and is an integral part of the channel alluvium in Horn Creek. The nature of the broken rock from the ore bodies would act like mine tailings and thus account for the existing AR at Horn Creek. This hypothesis is testable, and I am open to being	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			provided funds to do so. The Orphan Mine was discovered due to copper mineralization being exposed on the wall of the Grand Canyon at the Hermit Shale level. Note that the red line mirrors the pipe contact that exists within the standing wall of the cliff face and approximates what the missing part of the pipe might look like. The volume of the pipe that is missing is what eroded/fell from the cliff face and exposed the ore body of the Orphan Mine. The dark area extending down from the adit level is the A-zone ore body and reached grades of 1.5% U3O8. It could be extrapolated that this ore pod extended up into that volume of the pipe that has fallen from the face of the cliff. Indeed, the existing pipe above the adit level is mineralized with uranium, but at a grade not worth mining. This could be due to weathering and leaching actions which acted to strip mineralization from this exposed part of the pipe. The diameter of the pipe at the adit level is about 220 feet and the pipe can be traced upwards 350feet. The pipe would probably have flared out to a diameter of about 320 feet at the Coconino Sandstone unit. Using an average value for the pipe diameter above the adit level of 270 feet, the volume of the pipe that has been sent down into the canyon from the ore zone can be approximated. Volume of a cylinder = ((pi(3.14) x 270ft^2)/4)*350ft divide by 27 to get Cubic Yards. Volume = 741,825 cubic yards, but about 2/3 of the upper part of the pipe is missing, so about 500,000 cubic yards of material from the ore zone above the pipe has been sent down into the Horn Creek channel basin. Some of this material likely resides there still, and acts in the same way that mine tailings would.	
The NAU Project, LLC	242913		Continued... Sulfide ores in this material or perhaps gypsum dissolution from other rock units could account for the higher sulfate content of the waters in Horn Creek. This argument presents a valid non anthropogenic explanation for the water chemistry at Horn Creek and the higher levels of uranium in the creek water. It is very likely that the water coming from the spring at Horn Creek is elevated in uranium. The uranium mineralization in the Orphan ore body extends down into the Redwall limestone substantially and probably does contribute to the ground water activity in the vicinity of the mine. However, it would be a mistake to characterize the uranium content of the waters in Horn Creek to the mining activities at this time and to further extrapolate that this water is representative of attenuated mine waters that have passed through the intervening rock layers to the spring. The low volume of water that exits the rock face at the spring is sure to have deposited uranium enriched evaporates on the rock face and down the flow path both subsurface and on the surface from the spring over time. These evaporates could be remobilized under varying conditions of flow at the spring and the drainage basin and thus carry greater amounts of uranium into the Horn Creek water flow. Having put forth a reasonable argument that the higher concentrations of uranium in Horn Creek may not be from the Orphan mining operations per se, an impact analysis must be made for the possibility that uranium from actual	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			breccia pipe mine operations could find their way down to the roots of the breccia pipe in the Redwall Limestone via unconsolidated breccia or along the ring fracture zone that are still permeable to water flow. I don't have a problem with investigating this issue, I just don't believe that the evidence at the Orphan Mine is definitive and provides an actual scientific basis for the water quality analysis, given the age of the water at Horn Creek and the probable long transport time for the water through the rock strata. So the question is this, is 400 micrograms of uranium per liter an OK number to use? Given that around 600 μ-g/l was sampled inside the Orphan Mine in pooled water, 400 μ-g/l at a 1 gpm inflow, assumed to be directly injected, into the Redwall aquifer from a perched aquifer water source via mine openings is a good place to start. Now comes the sticky part. Some of the assumptions used in the water impact analysis are logically incompatible with known conditions in the R-Aquifers. Reductio ad absurdum arguments are made to disprove a proposition (correctly) and then the same argument is used to prove the same argument elsewhere (incorrectly). *****see submitall #242913 for table info**	
The NAU Project, LLC	242913		Continued... Page 4-61 The water samples obtained by Liebe (2003) below the Orphan Lode Mine provide the only example available of water that has been demonstrated to be affected by mine drainage (see isotope evaluation in subsection of Section 3.4 titled Legacy Impacts to Water from Uranium Mining) and that has been exposed to attenuating processes of dilution and adsorption/absorption in the fine-grained rock units between the mine openings and the R-aquifer but has likely not experienced significant attenuation and dilution during transport in the aquifer as a result of the relatively close proximity of the mine to the spring system. Obviously, I disagree that the Liebe(2003) study shows conclusive evidence that the Horn Creek water has been demonstrated to be affected by mine drainage. The age of the water in Horn Creek does not support a transport time consistent with mine affected water showing up in the creek water as of yet. The author's above statement continues and asserts that this mine water has been exposed to the attenuating processes of dilution and adsorption/absorption in the fine-grained rock units between the bottom of the mine and the R-aquifer, I find this claim and assumption to be highly unlikely. I think it more likely that mine waters would move rather quickly or very slowly to the R-aquifer from openings within a mine. If the rather quickly option is true, then very little attenuation via dilution or ad/absorption would be occurring. For the Orphan case to be true, and mine waters are indeed affecting the creek waters below the mine, then a rapid transport to the R-aquifer via fractures and connected voids in the breccia is indicated. Thus very little attenuation is occurring to the waters from the mine. On the other hand, should the breccia and pipe be fairly impermeable at the Orphan Mine, then due to the age of the waters in Horn Creek, the effects from the Orphan Mine are yet to come in the far future. That said, all this is besides the point, but I cannot just let	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			speculation and assumptions be set forth as if they were facts. The bottom line is this: for whatever reason, and by whatever means, if 400 µg/L at 1gpm enters the R-Aquifer below a breccia pipe what are the consequences?	
The NAU Project, LLC	242913	55 & 56	Page 4-61 The potential mine drainage is not affected by attenuation or dilution in the aquifer during transport and is only modified by instantaneous mixing with the volume of water discharging at the R-aquifer spring system for the basin analyzed. This assumption would tend to provide resultant concentrations that are conservatively high; however, sufficient data are not available to characterize flow paths and dilution rates in the R-aquifer from future mines. The above assumption does not constitute the basis for a credible impact model. I don't think anyone is asking for a perfect R- Aquifer subsurface transport and flow model for each location that a breccia pipe mine might be located (although I am sure the USGS would not turn down funds to do so over the next 20 years), but I really expected that the most important section in the EIS would have more going for it. This assumption is absurd on the face of it and is contrary to all of the sections regarding the geology of the R-Aquifer geological units. Conservatively high is really absurdly high! (Which is OK, if you are making a Reductio ad Absurdum argument!) The above assumption could, and appears to, be used in an reductio ad absurdum argument for the Havasu Springs calculation and it showed that due to the high volume of flow at the Springs that there could be no effect on the waters at Havasu Springs. However, this argument can only be used at springs where sufficient flow is available to disprove the proposition and cannot be used at low flow rate springs to prove the proposition. My basic comment here, is that you cannot posit transport of affected mine water over long distances and no mixing/dilution/attenuation with out stating that the assumption is absurd and that you will prove your proposition using that absurd assumption. Saying that it is conservative makes it seem like this assumption has some validity. It does not. The Liebe thesis itself actually provides the knife through the heart killing blow to the assumption for no dilution or attenuation. Taken at face value, the high levels of uranium contaminated water issuing (and measured) from the rock face above Horn creek of about 400µ-g/L was diluted and attenuated in just hundreds of feet to around 30µ-g/L or less by passing through the channel alluvium at a couple of gpm to locations measured and documented by USGS scientists. Clearly, the above cited portions of Chapter 3 indicate that there are two basic types of processes happening: water is moving slowly through permeable rock structures that include maze cave systems with gentle groundwater hydrological gradients and then moving into flow-through systems that rapidly move through the subsurface and have high flow rates. The flow-through systems occur near the spring outlets and the slow movement water occurs away from the outlets.	Please see responses to comments 242913, numbers 51, 52, and 53 directly above.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
The NAU Project, LLC	242913		Continued... Looking at the 'residence time graphic above' gives a definite feel to where these events are taking place. It is most likely, that in most locations where a breccia pipe mine might inject 400 μ-g/l at 1 gpm into the R-Aquifer, a plume of elevated U containing water will be created that will move slowly down the hydrolic gradient, mixing with other water over thousands of years in the pores and inter-grain voids of the R-Aquifer rock until part or all of that decreasingly concentrated plume enters the maze cave systems (that are huge reservoirs of water) where it will be diluted even further for several more thousand years until it then enters the fast moving flow-through systems, where it will be thoroughly mixed and and further diluted. The above statement describing the most likely scenario for "contaminated" water from a breccia pipe mine is totally missing from the Chapter 4 analysis and leaves an uninformed reader believing that perhaps the ridiculous assumptions presented are possible and true. I think we deserve a better analysis that this. A realistic statement of the transport time and probable dilution of any uranium contaminated water from a breccia pipe mine needs to be formulated and included in this EIS. Something on the order of what I proposed above. Consult the USGS hydrology experts for something they can all agree on! NEPA requires a better analysis than what is provided in Chapter 4. I think the major item to be determine is, how far from a breccia pipe does the U enriched plume have to travel to be diluted down to the ambient levels of the RAquifer. I think there is probably an APP for that! This could be modeled several ways, by looking at three separate cases of transport in the R-Aquifer, i.e., slow diffusion through the saturated zone, injection directly into a cave maze system, and then injection into a flow through system. Combinations of these transport models would also be modeled. Remember, these would be simplifies models to get an idea of how far or what volume of water is required to dilute the 400 μ-g/L at 1 gpm down to ambient levels. I think such models are within the capabilities of modern man to make and analyze and should be included in this EIS. For example, if the models indicate that the 400 μ-g/L@1gpm of uranium water will be diluted to ambient levels at a distance of 1 to 2 miles from a pipe and this process might take 100 to 5 thousand years, then a more reasoned analysis of the impacts could be made. The direction affected will be the hydrolic down-grade and the probable impacts to springs and wells could be more correctly determined. Afterall, by a review of the Liebe data and the USGS data taken at Horn creek, it can be seen that the uranium contaminated water was diluted in just a few hundred feet from around 400 μ-g/L to around 30 μ-g/L in a low flow situation and over a very short time period. NEPA requires an analysis based on credible scientific evidence and not one based on pure conjecture or not grounded in the rule of reason. A supplemental DIES should be prepared and issued to correct the failure to create and analyze simple models that would give a reality based idea of the the possible affects of elevated U leakage from a breccia pipe mine	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			into the R-Aquifer or it could simply be concluded that the South Rim springs are so poorly connected to the R-Aquifer away from the South rim, that due to dilution and attenuation no contamination of these springs is reasonably possible and so the impacts are none or negligible.	
The NAU Project, LLC	242913	57	Page 4-62 The Havasupai impact calculation should be identified in some way that it is a Reductio Ad Absurdum argument and for each such case where this argument is used.	The EIS describes existing conditions that are not favorable for mine drainage to occur to the R-aquifer from economically viable breccia pipe uranium deposits. However, uncertainties require that conservative assumptions be made and that the reasonably foreseeable impact include more than the possibility of no impact. These two concepts necessarily generate projected potential impacts that seem to be contradictory to existing conditions (including the assumption of no dilution or attenuation, except at the spring itself). Please refer to the response to comment 225260-29 (EFR) regarding this issue.
The NAU Project, LLC	242913	58	Page 4-63 The section on wells should ideally be based on one or more of the R-Aquifer models for determining the distance that a plume would probably travel before being diluted to ambient levels, then determine the possibility that a mine could be developed within that distance to the R-Aquifer well and then determine impacts. The section as it now stands, is wholly speculative and does not meet the requirements set forth in NEPA at section 1502.22.	There are no groundwater rights or well impact criteria regulated by the Arizona Department of Water Resources in this part of Arizona; therefore, it must be assumed that a mine site could be located in close proximity to an existing R-aquifer well or a future R-aquifer well where water demand is anticipated to grow and cause a need for such wells. Thus, it is not feasible to conduct the type of site-specific analysis suggested by this comment. The potential impact to water quality at such a well could range from none to major, as shown in Table 4.4-3 and the associated text in Section 4.4.4 (Subsection R-aquifer Wells Quality). Regarding groundwater modeling, please refer to the responses to comments 242654-13, 14, 17 (AZ Rock Prod. Assoc.) and 225286-4 (A. Springer) regarding the use of numerical or geochemical models. Regarding the methodology in DEIS and FEIS Section 4.4.1, refer to the response to comment 242913-57 (NAU Project).
The NAU Project, LLC	242913	59	Page 4-68 Therefore, it is assumed that any mine located within the potential impact area calculated for a spring might cause an impact ranging from none to major to that spring. However, the probability that a spring might be impacted by implementation of an alternative was evaluated for each parcel using the methods and assumptions described in Section 4.4.1. Results of this evaluation are summarized in Table 4.4-4. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 13.2%, which is classified as	There are no groundwater rights or well impact criteria regulated by the Arizona Department of Water Resources in this part of Arizona; therefore, it must be assumed that a mine site could be located in close proximity to an existing R-aquifer well or a future R-aquifer well where water demand is anticipated to grow and cause a need for such wells. Thus, it is not feasible to conduct the type of site-specific analysis

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			a moderate impact according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2). It is unclear that the math was done correctly to calculate these probabilities. See comments above for PAGE 4-51. I think a statement about the amount of probability inflation is warranted. To say conservative does not give a correct assessment, judging from the errors identified above.	suggested by this comment. The potential impact to water quality at such a well could range from none to major, as shown in Table 4.4-3 and the associated text in Section 4.4.4 (Subsection R-aquifer Wells Quality). Regarding groundwater modeling, please refer to the responses to comments 242654-13, 14, 17 (AZ Rock Prod. Assoc.) and 225286-4 (A. Springer) regarding the use of numerical or geochemical models. Regarding the methodology in DEIS and FEIS Section 4.4.1, refer to the response to comment 242913-57 (NAU Project).
The NAU Project, LLC	242913	60	Page 4-75 The analysis of this section can be used insofar as a Reductio Ad Absurdum (RAA) argument can be applied, given that the assumptions made are absurd. Where the argument is used to prove the proposition of elevated contamination, the RAA cannot be used and another more meaningful and realistic level of analysis must be employed. See previous comments on this issue.	Regarding groundwater modeling, please refer to the responses to comments 242654-13, 14, 17 (AZ Rock Prod. Assoc.) and 225286-4 (A. Springer) regarding the use of numerical or geochemical models. Regarding the methodology in DEIS and FEIS Section 4.4.1, refer to the response to comment 242913-57 (NAU Project).
The NAU Project, LLC	242913	61	Page 4-76 Table 4.4-5 I tried to duplicate the ambient concentration for small south rim springs by using the description of method in the notes and was unable to come up with the number 4µg/L as put forth in Table 4.5-5. I got 18.11µg/L . I think a spread sheet showing the calculations should be provided or at a minimum which specific records were used in the calculations. The calculations and records used could be made a part of Appendix F.	These calculations are in the project file and available upon request.
The NAU Project, LLC	242913	62	Page 4-77 The resulting projected total concentration of dissolved uranium at the springs ranges from 1.7 to1.8 µg/L, and the projected concentration of dissolved arsenic is 10 µg/L (see Table 4.4-5). The smaller uranium value and the arsenic value equal the ambient concentrations. The uranium concentrations do not exceed the EPA MCL for drinking water (30 µg/L) for humans, but the larger value does represent an increase from the ambient concentration. The analytical precision for an assay is anywhere from 5 to 10%, thus the difference of 0.1 µ-g/Lis hardly significant given the scenario of instantaneous mixing of 400 µ-g/L at the spring issuance. To apply a moderate impact rating for such a small deviation for an absurd calculation is ridiculous. Due to the absurd assumptions of transport with no dilution or attenuation, the above impact should be down graded to none to negligible.	Please refer to EIS Section 4.4.1 and Table 4.4-1 for definitions of impact categories. Where thresholds are used, it does not matter how close to the threshold the projected potential impact is as long as it exceeds the threshold. In addition, the 1.7 µg/L ambient concentration cited in this comment is an arithmetic average of several analyses, as are all the ambient concentrations listed in Table 4.4-1; thus, variation because of analytical precision is reduced in these calculations. The uncertainties are acknowledged in EIS Section 4.4.1.
The NAU Project, LLC	242913	63, 64, & 65	South Parcel Analysis Does not correctly apply a RAA argument for all cases. A better model and assumptions are required to determine the probable impact at low flow springs. An excerpt from the Grand Canyon National Park Water Supply Appraisal Study says: A number of other seeps and small springs issue from the Redwall-Muav aquifer within the	Although the conclusion stated in the cited excerpt from the Grand Canyon National Park Water Supply Appraisal Study (U.S. Bureau of Reclamation 2002) is based on sound, logical analysis of hydrogeologic conditions and is addressed under existing conditions

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			Grand Canyon. The seasonal nature and unsteady base flow of many of these seeps and small springs compared to the steady flow of Havasu, Hermit, and Indian Garden Springs support the conclusion that discharge from these seeps and small springs result mainly or solely from local near-rim recharge. Therefore, applying the 400µg/L of Uranium at 1gpm makes no since at all because the low volume springs are not connected to the South Rim aquifer system in any meaningful way. A review of the spring flow data for the South Rim shows two distinct flow rate groups. One group has 17 members and all have flow rates less than 9 gpm and have an average flow rate of 3.2 gpm. The other group has 7 members and have flow rates from 45 to 359 gpm. The Grand Canyon National Park in its Water Supply Appraisal Study indicated that the low flow springs and seeps were not connected or so poorly connected to the RAquifer that their water was concluded to come from near-rim recharge. I agree with this assessment. I also strongly disagree with the concept of applying a 1 gpm flow of Uranium enriched water at 400µg/L into an average 3.2 gpm flow from a non-rim source. Suggesting that your contamination source be 1/4 of your total mixed flow is unrealistic (Not in compliance with NEPA) given the geologic setting and the probable location of any breccia pipe mine. Therefore, all such low flow springs and seeps should be excluded from contamination considerations and calculations, because they are simply not connected sufficiently to the R-Aquifer to begin with. However, if you simply cannot be content with this, then I propose the following. From Section 3.4.6 and page 3-76: The results of isotope studies reported by Monroe et al. (2005) and Bills et al. (2007) suggest that a fraction of the water from several of the springs may have slowly percolated downward from land surface and/or flowed from more distant parts of the aquifer, and that the small, local drainage basins at the Canyon rim may not be the only source of water for these springs. Note the use of the words: suggests, fraction, several, and may. This word usage indicates a high degree of uncertainty and thus speculation and really only apply to a handful of springs anyway, which by the way are unidentified as well. In addition, the more "distant parts of the aquifer" are most likely parts of the aquifer North of the ground water divide.	in EIS Section 3.4.6 (Subsection Discharge from R-Aquifer Springs), it does not preclude the possibility of recharge from more distant parts of the aquifer or quantify the relative proportion of such recharge. Therefore, the EIS necessarily uses the same methodology for these small seeps and springs as for larger springs. Because of the relative volumes of projected potential mine drainage and the discharge rates of the small seeps and springs, it is not necessary to conduct additional analyses to justify the potential for a major impact. Since EIS Table 4.4-3 gives potential impacts to South Rim springs ranging from none to major, the possibility of no impact is included in the analysis. Please refer to response to 242913-58 (NAU Project) regarding R-aquifer well impacts. The analysis of potential impacts on R-aquifer wells is given in EIS Section 4.4.1 (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells - Wells) and results are given under each alternative. Section 4.4.4 of the FEIS refers to the location of the analysis (in the Methodology section).
The NAU Project, LLC	242913		Continued... I propose using a fraction of the 1 gpm at 400 µ-g/L uranium concentration for instantaneous mixing at the outlet of the low flow springs. Please note that due to the low flow conditions considered, any additional concentrations of uranium will cause a moderate impact given the impact descriptions defined in Chapter 4 and so what we are determining is the possibility of a major impact. I calculate the average flow for Low flow springs from Appendix D to be about 3.2gpm and the average ambient uranium concentration in these springs to be about 5.4µg/L. The uranium contaminated water is 400µg/L at 0.0 to 0.15 gpm corresponding to 0 to 15% of the stated assumed 1gpm attributable to breccia pipe mining. Doing the math you find that at 0% contribution there is no impact, and at	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			15% contribution the projected concentration increases from 5.2 to 23.1µg/L , which is below the EPS MCL for drinking water (30 µg/L). This puts all impacts, from an absurd assumption scenario, at no impact to moderate impact for a long term duration for the low flow springs of the South withdrawal parcel. As noted in the DEIS, where the U concentration are greater than the EPS limit, those sites continue to have major impacts, but there is no increase in effective impact. However, since the above impacts are based solely on an absurd assumption of no dilution or attenuation over long transport distances and time, these impacts should be downgraded to none and negligible given the very low probability of these springs being actually connected to the regional aquifer north or south of the groundwater divide. The following list of springs from Appendix D are the higher flow rate springs and make up the second group of South rim Springs mentioned above. I will used the data for each exclusive of the Havasu Springs, Blue Springs, Hermit Springs, and Garden Springs which were calculated in the DEIS. For 1 mine contributing to the flow of: Two Tree Springs(221 gpm, 2.33 µ-g/l U), A-31-0313 (180gpm, assumed 3 µ-g/l U), Pipe Creek(104 gpm, 3.31 µ-g/l U), Hawaii Springs(359 gpm, 2.44 µ-g/l U) and A-31-0216(44.8gpm, 7.2 µ-g/l U) The DEIS did not specifically call out which springs were included in the small South Rim springs calculation, so I included all that had higher flow rates and were not calculated separately in the DEIS. The increase in uranium concentration is as follows for these springs, using the same method as in Section 4.4.1.	
The NAU Project, LLC	242913		Continued... Projected Concentration Two Trees: 4.12 µ-g/L A-31-0314 5.19 µ-g/L Pipe Creek 7.09 µ-g/L Hawaii Spring 3.54 µ-g/L A-31-0216 15.78 µ-g/L As can be seen from the above list, each spring had an increase in projected uranium concentration, but none were above the EPS MCL for drinking water (30 µ-g/l). This redefines all impacts, from an absurd assumption scenario, at no impact to moderate impact for a long term duration for the South withdrawal parcel. However, since the above impacts are based solely on an absurd assumption of no dilution or attenuation over long transport distances and time, these impacts should be downgraded to none and negligible. The impacts for the Havasu Springs and Blue Springs should be downgraded to no impact. The impact for Hermit Springs and Garden Springs should be downgraded to none and negligible.Page 4-78 R-Aquifer Wells Quality South Parcel: Based on the description given in Section 4.4.1 of potential impacts to R-aquifer quantity and quality, together with the description given in the present discussion for R-aquifer quantity, it is considered unlikely but possible that water quality at R-aquifer wells at Tusayan or Valle could be impacted by anticipated mining operations in the South Parcel for the 20-year period of this analysis. This result would be considered to represent a range from no impact to major impact, according to the criteria given in Table 4.4-1. Duration of the impact would likely be long term (defined in Table 4.4-2).	

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			This section provides no analysis whatsoever for the determination of the impacts of mine related water uranium contamination on R-Aquifer wells. On page 4-63 of the DEIS it is stated: Because data are insufficient to estimate the specific flow paths and dilution in the aquifer at future mines, it is not possible to quantitatively project the potential impacts to chemical quality at non-mine R-aquifer wells, if such impact were to occur. Therefore, it is assumed that the potential impact would range from none to major. Duration of the impact would likely be long term (defined in Table 4.4-2).	
The NAU Project, LLC	242913		Continued... These two statements of impact are counter to the requirements of NEPA, as no credible scientific evidence is offered and is based purely on conjecture. However, insufficient data did not stop the authors from creating a contamination scenario, complete with absurd assumptions, for R-Aquifer Springs, so what's the issue here? So, what you are going to say instead is, lets make something up because we have no clue? If you're gonna posit 400 µ-g/L U at 1 gpm undiluted and unattenuated to the outlet of a Spring, you might as well do it for the wells too! There are three wells at Tusayan and two wells at Valle. I propose that they be consider the same as a Spring Complex and thus the GPM flow for Tusayan is 3 time 65 gpm(for each well) or 195gpm and similarly, the Valle well complex would have a flow rate of 130 gpm. Using 4 µ-g/l U concentration for both well sites (assumed, as I have not been able to find true values) the Projected values for Uranium concentrations at Tusayan Well Complex is 6.0 µ-g/l and at Valle 7.0 µ-g/L Both of these projected concentrations are an increase over ambient conditions, but none were above the EPS MCL for drinking water (30 µ-g/l). This then puts all impacts, from an absurd assumption scenario at, no impact to moderate impact, for a long term duration in regards to R-Aquifer well affected by mining in the South withdrawal parcel. However, since the above impacts are based solely on an absurd assumption of no dilution or attenuation over long transport distances and time, these impacts should be downgraded to none and negligible. NEPA requires that the determination of impacts be based on credible scientific evidence and not upon pure conjecture and that analyses used be within the rule of reason. Therefor, the analytical models used must be more substantial than are offered in this DEIS. The entire Water Quality section needs a re-write to conform to the analytical requirements of NEPA.	
The NAU Project, LLC	242913	76	The Water Resources Impact section is totally devoid of any suggestions for mitigating measures, even though this section is one that claims many higher level impacts to water resources. That no mitigating measures are proposed, is not in compliance with NEPA. A possible mitigation measure that could be investigated, and would address one of the central issues of water resource impacts is the issue of the possibility that some breccia pipes might be permeable and allow mine tainted water to seep down into	This EIS is an analysis of a mineral withdrawal proposed by the Secretary of Interior and two alternative withdrawals. No specific mine operations are being addressed, nor will any be authorized as a result of this analysis. The description of mine inspections and other techniques (mitigations) to reduce environmental impacts and assure compliance

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			the RAquifer. I would propose the following mitigating measures for reclaimed mines: Apply a sealant to the exposed low grade ore that will be left in place such that water flowing over the surface will not come into actual contact with the rock surface. In addition, the bottom of the mine could have a granulated filter media containing minerals that would have an extremely large surface area within the media that would act like sinks for any uranium that had become soluble in water. As the uranium enriched water passed through the media at the bottom of the mine, the uranium would be precipitated out and tightly sequestered such that it would be unlikely to be remobilized at a later time. Modeling could be done to determine the depth to which the media should be infilled and the amount of uranium in solution that it could capture. This kind of media could also be put in the mine sump, when the mine is in operation. These are the kinds of mitigating measures that should be generated to address many of the impacts that this EIS has come up with. I find it quite disturbing that the most popular mitigating measure proposed is just the Alternatives that reduce the area available for mineral entry. A greater effort is required by NEPA than the one that has been made so far in the writing of this DEIS.	to laws and regulations would be established at the time of the site-specific NEPA analysis of a new Mine Plan of Operations.
The NAU Project, LLC	242913	82	If mine drainage were to occur from a breccia pipe uranium mine within this capture zone and, although it is unlikely, if the mine drainage were to reach the R-aquifer and not be mitigated, it would be possible for the mine drainage to eventually become part of the groundwater yielded to the Tusayan wells at a highly diluted concentration. So what is your mitigating measure that you think might work?	This EIS is an analysis of a mineral withdrawal proposed by the Secretary of Interior and two alternative withdrawals. No specific mine operations are being addressed, nor will any be authorized as a result of this analysis. The description of mine inspections and other techniques (mitigations) to reduce environmental impacts and assure compliance to laws and regulations would be established at the time of the site-specific NEPA analysis of a new Mine Plan of Operations.
The NAU Project, LLC	242913	84	Water Resources Section page 4-65 It should be emphasized that detailed, site-specific environmental analysis would be required for any new mines in the proposed withdrawal area and that the data necessary to assess the potential impacts on a case by case basis would be obtained and evaluated at that time. In addition, the ADEQ may require new Aquifer Protection Program (APP) permits for reactivation of existing mines operating under interim management plans; these permits can include measures for monitoring and environmental mitigation (for example, see ADEQ 2009d). This does not relieve you from offering mitigating measure for this EIS.	This EIS is an analysis of a mineral withdrawal proposed by the Secretary of Interior and two alternative withdrawals. No specific mine operations are being addressed, nor will any be authorized as a result of this analysis. The description of mine inspections and other techniques (mitigations) to reduce environmental impacts and assure compliance to laws and regulations would be established at the time of the site-specific NEPA analysis of a new Mine Plan of Operations.
Robert Grossman	242968	1	You state that water for dust ccontrol would come from an aquifer. Define the impact of such water withdrawal on the aquifer and other users of the aquifer water.	The potential impacts under Alternative A (no withdrawal) for all mine water withdrawals, including those for dust control, are discussed for springs and wells in EIS Section 4.4.4 (Subsection R-aquifer Springs Quantity). In addition, it should be noted that

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				seepage from perched aquifers penetrated by mine openings is collected in the mine sump and used for dust control; potential impacts to perched aquifer springs and wells under Alternative A are discussed in EIS Section 4.4.4 (Subsection Perched Aquifer Springs and Wells Quantity and Quality).
VANE Minerals	242650	15	Nowhere in the DEIS does it state that a direct positive impact of mining uranium from breccia pipes is that it removes the uranium that is the source of concern in the first place.	The fact that the high-grade ore at economically viable breccia pipe uranium deposits is preserved indicates that the hydrogeologic conditions at these sites are not favorable for groundwater to move naturally through the deposits. However, mining operations create openings that may be exposed to oxidation and drainage of perched groundwater. At the end of mining operations at such a site, it is not reasonable to assume that ore removal was 100% efficient or that there is no uranium-bearing rock remaining exposed in the openings or backfilled into the mine during reclamation as waste rock.
Sustainable Economic Development Initiative of Northern Arizona	54353	10	Examples of other effects not considered in the DEIS include significant weather changes over the next 20 years, including Black Swan effects - refers to the disproportionate role of very high-impact, hard to predict, and rare events in history and science. (Taleb, Nassim Nicholas, 2007: The Black Swan, Random House, New York.) A recent example is the impact of the 9.0 earthquake and tsunami on several nuclear reactors in Japan. Apparently, to save money both the design and operation of these nuclear reactors were based on more probable disturbances. Last year's BP oil spill in the Gulf provides another example of cost-cutting shortcuts when a full scale blow-out was deemed to be improbable. When an improbable event could be catastrophic, with long-term impacts, however decision-making based only on probabilities is inadequate. In the case of chemical water pollution by mining wastes or uranium, for example, the DEIS claims the overall cumulative risk for perched aquifer springs is moderate for the north parcel and negligible for the east and south parcels. (DEIS, p 4-84) Other DEIS comments, however, do not support this conclusion. For example: the DEIS acknowledges the estimated pollution impact probability to north parcel springs as 13.2% under Alternative A, (DEIS, p 4-70) at the same time noting that "incomplete and unavailable information adds to the uncertainty of analysis. (DEIS, p 4-65) The DEIS also notes that "there is currently no conclusive evidence from well and spring sampling data that breccia pipe uranium mining operations in the North Parcel have impacted the chemical quality of groundwater in the regional R-aquifer," but acknowledges that "the travel time for some impacts to wells and springs may be longer than the time that has passed since uranium mining began in the North Parcel." (DEIS, p 4-60)	NEPA does not require a worst-case scenario analysis (this analysis was withdrawn by final rule issued at 51 Fed. Reg. 15618, Apr. 25, 1986), only analysis of circumstances that are reasonably foreseeable is required. Appendix B provides this reasonably foreseeable development scenario and provides a rationale to why this scenario is used. The description of existing conditions in EIS Section 3.4 together with the conservative methodology described in Section 4.4.1 to project potential impacts to water resources lead to conclusions that are unlikely to be affected by changes in average weather conditions in the region over the next 20 years. As described in EIS Section 4.4.3, environmental regulations and permitting require mine site design to account for certain levels of extreme weather. However, if extreme weather or other events would cause violations of the mine permits, the responsible oversight agency would require specific mitigation measures to be developed on a case-by-case basis to correct the violations. There is nothing inconsistent with the EIS citations made in the first half of this comment. The EIS characterizes potential impacts to water resources according to the methodologies and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				definitions in Section 4.4.1. Lacking established standards, the EIS does not make judgments about the acceptability of projected potential impacts or risk of impacts.
Sustainable Economic Development Initiative of Northern Arizona	54353		*#10, continued....* The DEIS comes close to acknowledging the potential impact of current level drought conditions when it notes that "impacts to R-aquifer springs range from negligible impact (concentrations of uranium and arsenic remain at ambient levels) where spring flow is large (East and South parcels), there might be a major impact (exceedances of drinking water quality standards) where spring flow is small (South Rim springs north of South Parcel)." (DEIS, p 4-80) Increasing drought conditions would likely make increase the impact because of reduced flows in all springs. These comments do not support the precision implied in an impact probability of 13.2%, or a conclusion that impact effects are "negligible". Even a characterization of the potential impact of uranium contamination of the Colorado River as 13.2% or as "negligible" creates an unacceptable risk given the significant consequences of an event characterized as "improbable". One way of dealing with the possibility of black swan events is use a Failure Mode and Effects Analysis (FMEA) customized to the uranium ore mining and transportation process on a full life cycle basis, i.e., covering the full life cycle of uranium ore's pollution potency. This approach provides a way to incorporate low probability but high impact outcomes into the decision making process. We were not able to identify any consideration of this important analytical approach in the DEIS.	
Arizona Department of Environmental Quality	225269	2	The DEIS makes a number of assumptions regarding water quality and recharge of the R-aquifer at current and potential mines that are not consistent with actual conditions or permits issued for operation and reclamation of new mines. Specifically: The DEIS states that the potential for impacts to local perched aquifers is dependent on the presence and location with respect to uranium ore within a particular breccia pipe. Under the DEIS assumption that future mines would be evenly spaced and that perched aquifers are notcontinuous, BLM estimates that impacts would range from "none" to "major" and such impacts would occur due to mobilization of· chemical constituents and handling of waste rock. ADEQ has not observed a wide-spread presence. Of perched aquifers at any of the ADEQ permitted mining sites ininearthe DEIS study area. Only one minor perched aquifer has been identified, and its presence can be attributed to an overlying stock watering pond. In all known cases; ore bodies have been located far below the elevation of any potential perched aquifer, rendering any potential perched aquifer impacts negligible.	<u>PERCHED AQUIFERS:</u> The assumptions and methodology for projecting potential impacts to perched aquifers are given in EIS Section 4.4.1 (Subsection Quantity of Discharge from Perched Aquifer Springs and Wells). Potential impacts are discussed under each alternative in EIS Sections 4.4.4 through 4.4.7. In addition, please refer to EIS Section 3.4.6, Subsections Recharge, Groundwater Occurrence in Perched Aquifers, and Discharge from Perched Aquifer Springs. Data are insufficient in the large study area to determine where perched aquifers occur and the location of future mines is not known. Therefore, a random distribution was used to evaluate the probability of a mine impacting a perched aquifer. The recharge assumptions were based on infiltration of a fraction of the natural precipitation in the region. Perched aquifers are not uncommon and, in fact, were

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				encountered in the base of the Coconino Sandstone (underlain by the Hermit Formation perching layer) at most of the former and existing breccia pipe uranium mine sites in the study area. If a perched aquifer is penetrated by mine openings, perched groundwater can drain into the mine openings, thus depleting the aquifer. Unless the perching layer is re-established during mine reclamation, the perched aquifer will continue to drain into the mine openings and will not be replenished. If the perched aquifer discharges at a perched spring, the spring could be impacted. If there is any residual ore in the mine openings at the perched aquifer horizon, or if waste rock that contains residual mineralization is placed in this horizon, additional migration of recharge water through this horizon could mobilize uranium and other minerals. Even if the perching layer is re-established during mine reclamation, perched groundwater moving laterally through this horizon could still mobilize uranium and other minerals, if present. In Table 4.4-3 potential impacts to perched aquifer springs are characterized as ranging from none to moderate, based on the location of springs and the projected recharge areas. Potential impacts to perched aquifer wells are characterized in Table 4.4-3 as ranging from none to major because such a well may or may not tap an aquifer that could be penetrated by a future mine. R-AQUIFER: The assumptions and methodology for projecting potential impacts to the R-aquifer are given in EIS Section 4.4.1 (Subsections Discharge from Regional R-Aquifer Springs and Wells; and Chemical Quality of Regional R-Aquifer Springs and Wells). Potential impacts are discussed under each alternative in EIS Sections 4.4.4 through 4.4.7. In addition, please refer to EIS Section 3.4.6, Subsections Recharge, Groundwater Occurrence and Movement in the R-Aquifer, and Discharge from R-Aquifer Springs.
Arizona Department of Environmental Quality	225269	3	The DEIS makes a number of assumptions regarding water quality and recharge of the R-aquifer at current and potential mines that are not consistent with actual conditions·or permits issued for operation and reclamation of new mines. Specifically: The DEIS assumes that one gallon per minute (gpm) of drainage containing 400 mg/l of uranium would be passing through each mine and would eventually reach the R-aquifer. 400	Please refer to the responses to comments 225269-2 (ADEQ) and 225260-24 (EFR). Water quality data for concentrations of uranium in groundwater that passes through a breccia pipe uranium mine to the R-aquifer are very limited; therefore, conservative assumptions must be made using the best data available. The basis

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			mg/l described as the highest concentration detected in water from below the historic (un unreclaimed) Orphan Lode Mine.This theoretical concentration of uranium in water was then applied to all potential mines in the area for purposes of estimating potential impacts to R-Aquifer water quality. These assumptions grossly overestimate potential impacts to the R-aquifer as: all mines would need to be continually exposed to percolating groundwater (an unrealistic assumption); each mine would need to contribute one gpm (or about 650,000 gallons per year) of high uranium drainage to the R-aquifer; and, no mines are assumed subject to dewatering or reclamation (sealing) to prevent water percolation during or subsequent to operation as is required by current permits.	for the assumption of a concentration of 400 mg/L is given in EIS Section 4.4.1 (Subsection Chemical Quality of Regional R-Aquifer Springs and Wells). As described therein, chemical analyses reported by Liebe (2003) are the only data available for water that moved through an unreclaimed breccia pipe uranium mine (Orphan Lode Mine) after mining operations had ceased. The projected potential impacts are not based on an assumption that all of the mines would continue draining 1 gpm; only as many as half of the mines estimated in the RFD are assumed to continue draining, including zero mines. A cumulative inflow of 1 gpm seeping from potentially several surfaces of a horizon penetrated by mine openings would not appear to be significant visually and is, in fact, the same magnitude of discharge reported for many of the perched aquifer springs in the North Parcel, which are supported by recharge to perched aquifers (Figure 3.4-11). The 1 gpm rate is also approximately equal to the maximum average flow of perched groundwater into mine openings for former breccia pipe uranium mines in the North Parcel (see EIS Section 3.3.4). One of the most significant uncertainties is the pathway by which mine drainage might reach the R-aquifer. Although, as stated in Section 3.4.4, low permeable conditions at economically viable uranium ore deposits in breccia pipes are not favorable for downward migration of leached minerals, there are insufficient data to preclude this possibility at all locations. Due to uncertainties, it is prudent to make conservative assumptions, even if they may overestimate the potential impacts.
Arizona Department of Environmental Quality	225269	4	The DEIS makes a number of assumptions regarding water quality and recharge of the R-aquifer at current and potential mines that are not consistent with actual conditions· or permits issued for operation and reclamation of new mines. Specifically: The DEIS acknowledges that "It is assumed for the purposes of this impact analysis that the impact to surface streams is equivalent to the impact on the springs supplying discharge. This assumption could lead to a conservative overestimation of impacts if a stream is fed by multiple springs that are not all impacted and because in "stream attenuation is ignored". In addition to this acknowledged overestimation of surface water impacts, the analysis of potential impacts to surface waters would be further overestimated due to the overly conservative assumptions made during the assessment of R-aquifer water quality discussed above.	Data for field water quality samples and spring flow are limited in the study area; therefore, conservative assumptions must be made using the best data available. Although the assumptions used to analyze impacts to perennial surface streams in the study area may result in overestimation of potential impacts, they are appropriate given that: 1) even if the stream is fed by multiple springs, at least one segment of the stream would experience an impact equivalent to that at the source spring and, because this EIS is not site-specific, it is not possible to determine which springs/streams might be impacted; and 2) in-stream attenuation is likely to be negligible because, on

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				average, the perennial surface water reaches are very short and fed only by a single nearby spring or closely arranged spring complex.
Arizona Department of Environmental Quality	225269	5	The DEIS makes a number of assumptions regarding water quality and recharge of the R-aquifer at current and potential mines that are not consistent with actual conditions·or permits issued for operation and reclamation of new mines. Specifically: The DEIS cites United States Geological Survey, in its 2010 publication Hydrological, Geological; and Biological Site Characterization of Breccia Pipe Uranium Deposits in Northern Arizona: *Water migrating from the surface to the subsurface is an important trarisport mechanism for the remobilization oftrace and radiochemical elements. Since most of the orebodies associated with breccia·pipes are located several hundred to more than 1,000 ft above the regional groundwater flow systems of northern Arizona, natural recharge of water from the surface through these orebdies is one of the few ways of riaturay adding to the radiochemistry of the regional groundwater flow systems.* (Page 9) Though the USGS believes natural recharge occurs through breccia pipes and adds radionuclides to the R-aquifer, the DEIS does not appear to differentiate between such natural recharge and potential recharge through mining activity. .	Please refer to the response to comment 225280-13 (ASLD).
Arizona Department of Environmental Quality	225269	6	The DEIS makes a number of assumptions regarding water quality and recharge of the R-aquifer at current and potential mines that are not consistent with actual conditions·or permits issued for operation and reclamation of new mines. Specifically: In addition, the Arizona Geological Survey (AGS), who worked with the BLM as a cooperathig agency during development of the DEIS, has completed a study of the amount of naturally-occurring uranium in the Colorado River and the possible impacts of additional uranium entering the river as a result of accidental discharge from current and potential uranium mining in Northern Arizona (attached). The AGS concluded that even under hypothetical worst-case scenarios of releases of uranium ore directly to the Colorado River, uranium concentrations would not exceed applicable regulatory standards.	The potential water quality impact to the Colorado River is discussed in EIS Section 4.4.4 (Subsections Surface Waters, Water Quality). Although Spencer and Wenrich (2011) was not relied upon in conducting the EIS analysis of impacts to the Colorado River, the results of the analysis in this EIS are consistent with their findings.
Coconino County Board of Supervisors	225238	10	According to the DEIS (Appendix B, page B-37), the estimated water use for each mine is estimated at 10.5 million gallons over a four-year mining period. While this is tiny compared to water use in Phoenix or Flagstaff, it is still a substantial amount of water. It is about 15% of the amount of water used in the community of Tusayan on an annual basis, for example. While small, the potential for impacts on seeps and springs in the Grand Canyon is considerable.	Potential impacts to seeps and springs in the Grand Canyon from mine well use are discussed under each alternative in EIS Sections 4.4.4 through 4.4.7 (Subsection R-aquifer Springs Quantity).
Coconino County Board of Supervisors	225238	11 / 12	County staff also was told by BLM officials at one of the cooperating agency meetings that there is no requirement for the timely reclamation of mothballed mine sites. The Kanab North mine site has been mothballed since the late 1980's. Unlike a mine that proceeds totally according to plan,	The Kanab North Mine was approved in the late 1980s and mining was conducted there until the collapse of the Soviet Union caused uranium prices to plummet. The regulations under which the mine was approved

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			with exploration, planning, permitting, mining, and reclamation all occurring within a seven-year window, if the price of uranium declines and companies walk away from mines because they are no longer economically feasible to operate, reclamation could wait 50 or 100 years after a mine site is mothballed. Several years ago the Board of Supervisors toured the Kanab North mine site and there was water in the retention ponds, and the liner appeared to have significantly deteriorated over time, potentially allowing contaminated water to leak into underlying aquifers and affecting spring water quality, possibly decades later. This begins to suggest that the very long-term cumulative impacts on water quality are not very well understood.	allowed for the mine to be managed under Interim Management until the company could economically reopen the mine. There was no time limit for operating under Interim Management in the regulations when the Kanab North Mine was approved. The Kanab North mine remained under interim management for over 20 years because the mine owner believed it might be feasible to re-start active mining operations. Recently, the mine owner has reconsidered the feasibility of reopening the Kanab North and they are preparing to close the mine and reclaim the site. The mine owner is working with BLM to develop a timeline for implementation of the reclamation plan, and is coordinating with ADEQ to determine if additional requirements must be met for closure. Please refer to EIS Section 4.4.3 regarding monitoring, mitigation, and financial guarantees that may be required by ADEQ and/or BLM for re-activation and closure of existing mines operating under interim management plans.
Washington County Commission	225251	4	A recent study completed by the Arizona Geological Survey, conducted by Drs. Spencer and Wenrich using data published by the U.S. Geological Survey, concluded that 40 to 80 tons of dissolved uranium (not uranium ore) are currently being carried by the Colorado River through northern Arizona and the Grand Canyon every year. According to their study, the proposed withdrawal area has one of the highest concentrations of naturally-occurring uranium in the world with many deposits exposed in the walls of the canyons across the area. Uranium has been eroding from these naturally-occurring deposits for millions of years and will continue to do so for millions more. In the study, they considered a hypothetical, worst-case transportation accident in which a truck hauling thirty metric tons (66,000 pounds) of ore containing one-percent uranium is overturned by a flash flood in Kanab Creek and its entire ore load is washed into the Colorado River where it is pulverized and dissolved during a one year period and thereby becomes part of the dissolved uranium content of the river (a highly implausible, if not impossible scenario). The addition of 300 kilograms (660 pounds) of uranium over a one year period would increase uranium in river water from 4.00 ppb to 4.02 ppb, an increase of one-half of one percent - an amount they concluded would be undetectable against much larger natural variations in river-water uranium content.	The potential water quality impact to the Colorado River is discussed in EIS Section 4.4.4 (Subsections Surface Waters, Water Quality). Although Spencer and Wenrich (2011) was not relied upon in conducting the EIS analysis of impacts to the Colorado River, the results of the analysis in this EIS are consistent with their findings. Please refer to the response to comment 225280-13 (ASLD) for additional discussion.
San Juan County Commission	243250	7	Uranium contamination of the Colorado River was one of the primary concerns raised by former Arizona State Governor Janet Napolitano and Secretary of Interior Ken Salazar in implementing the temporary federal	The potential water quality impact to the Colorado River is discussed in EIS Section 4.4.4 (Subsections Surface Waters, Water Quality). Although Spencer and

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			segregation on the Arizona Strip Area. A recent study completed by the Arizona Geological Survey conducted by Dr. Spencer and Dr. Wenrich using data that was produced by the USGS concluded that forty to eighty tons of dissolved uranium (not uranium ore) are currently being carried by the Colorado River through northern Arizona and the Grand County every year. This study indicated that the proposed withdrawal area has one of the highest concentrations of naturally-occurring uranium in the world with manyofthe deposits exposed in the walls ofthe canyons across the area. Uranium has been eroding from these naturally-occurring deposits for millions of years and will continue to do so for millions more. There is no action that can be done through the DEIS to change this fact of nature.	Wenrich (2011) was not relied upon in conducting the EIS analysis of impacts to the Colorado River, the results of the analysis in this EIS are consistent with their findings. Please refer to the response to comment 225280-13 (ASLD) for additional discussion.
U.S. Fish and Wildlife Service	242660	35	Also, please clarify the effects to perched aquifers from mines that are in interim management mode. Water quantity (see page 4-71) and presumably water quality in these aquifers would continue to be affected during this period, while mines are not being actively operated, but have not been reclaimed.	The decision to not analyze impacts during periods of non-operation (i.e., interim management) was made for two reasons: first, that reasonably foreseeable demand for uranium is not expected to lead to mines on stand-by and, secondly, mines operating under interim management are operating according to an approved interim management plan that defines how the site will be managed, allowing the BLM and Forest Service to determine what activities will be allowed on the site during those periods, if they should occur. Mining operations must still comply with environmental regulations and laws even while under interim management.
Arizona State Land Department	225280	13	In Subsection B.4.1 on page B-11 , the RFD notes that the first breccia pipes were originally discovered as a result of their exposures in the walls of the canyons. However, there is no discussion anywhere within the RFD or the DEIS of how many pipes are naturally exposed within, and how much uranium is consequently being naturally eroded and released into, the Colorado River watershed. The Arizona Geological Survey (AGS) did a recent study of these naturally exposed breccia pipes, and found that the amount of uranium naturally eroding into the watershed from these exposed breccia pipes would greatly exceed any accidental release of uranium from mining activity.	EIS Section 3.4.4 provides some discussion of natural release of uranium into the environment from breccia-pipe ore bodies. The number of known breccia pipes exposed is discussed in this section and these pipes are shown on Figure 3.4-5. Breccia pipe uranium deposits appear to be the source of widespread low to moderate concentrations of dissolved uranium in groundwater throughout the region. The article referenced by the commenter (Spencer and Wenrich 2011) discusses background concentrations of dissolved uranium in the Colorado River. Although some influx of dissolved uranium to the river likely occurs in the study area as a result of natural erosion of uranium deposits in the Grand Canyon region, based on available data there has been no increase in dissolved uranium concentrations in the river within the study area (see Section 3.4.7). Data for uranium-bearing sediment loads in the Colorado River upstream and downstream of the study area are not available.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
Wilderness				
Denison Mines Corp	104145	7	Further, the lands in question have already undergone evaluation and decision for withdrawal. In the 1980's, the uranium industry, federal government and environmental groups agreed on the terms of the Arizona Strip Wilderness Protection Act of 1983, which became law in 1984. The act, drafted by Arizona lawmakers Mo Udall, Barry Goldwater, Bob Stump, Jake Gam, and John McCain, sought to keep open for multiple use, including mineral entry, much of the acreage being targeted by this proposal. The operations of the uranium industry on the Arizona Strip have been a testament to this having been the right decision. This withdrawal proposal ignores that history.	The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses. The Secretary of the Interior, under the authority of Section 204 of FLPMA, may implement a withdrawal of over 5,000 acres of public lands for a period of up to 20 years.
American Clean Energy Resources Trust (ACERT)	225256	20	Pages 1-10 through 1-18 Statement: *A number of legal authorities apply to the processing of the proposed withdrawal application and preparation of the associated EIS. These include laws, policies, and orders that established the basic tenets of the Mining law, set the requirements for consultation between federal agencies and tribal governments, formulated the policies on the use of federal lands, promulgated the regulations for mining on federal lands, and set overall management objectives in agency legislation.* It is almost inconceivable that the architects of this DEIS would omit Public Law 98- 406 (the Arizona Strip Wilderness Act) from the list of legal authorities. When passed and signed into law in 1984, the Arizona Strip Wilderness Act was thought to have once and for all addressed any and all questions of wilderness and conservation in northern Arizona. The Arizona Wilderness Act specifically recognized the uranium potential of over one half million acres of Bureau of land Management (BLM) and U.S. Forest Service lands in northern Arizona by releasing them from wilderness classification so they could be explored and mined. With overwhelmingly strong bipartisan support from all factions across the entire political spectrum of the time, Congress spoke and clearly defined the disposition of public lands in northern Arizona. Most believed that the years of controversy and debate, as well as the uncertainty and constant reevaluation, were over. However, it would appear that (with this DEIS) the wheel is again being reinvented. The omission of Public law 98-406 (Arizona Strip Wilderness Act) is clearly prejudicial against the uranium mining industry.	The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses. The Secretary of the Interior, under the authority of Section 204 of FLPMA, may implement a withdrawal of over 5,000 acres of public lands for a period of up to 20 years.
American Clean Energy Resources Trust (ACERT)	225256	105	Pages 4-215 to 4-220 Page 2-42, Table 2.8-1 Statement**: Entire Section** Comment: There are three wilderness areas adjacent to the withdrawal parcels, and one area of land managed to maintain wilderness characteristics. The Kanab Creek Wilderness is next to the North Parcel, and the "managed land" adjoins this. The Paria Canyon-Vermilion Cliffs and Saddle Mountain Wilderness areas are adjacent to the East Parcel.	Impacts to wilderness have been analyzed according to the definitions of the characteristics that constitute a wilderness, as specified in the Wilderness Act, in Section 4.13, Wilderness. The FEIS has been updated to include existing conditions and analysis of impacts to BLM, Forest and NPS wilderness characteristics in

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			No wilderness areas adjoin the South Parcel. Characteristics that determine a wilderness are that the land should be untrammeled, natural, undeveloped, and provide solitude or a primitive and unconfined type of recreation. The definitions of these characteristics are given in the Wilderness Act of 1964 [PL 88-577; 16 USC 1131-1136]. 1. The DEIS states that the mining activities being considered in the document "would not result in any direct impacts to designated and proposed wilderness areas." 2. With the analysis provided in the Soundscapes section of the DEIS (Section 4.10), it is evident that there will not be any noise impacts if the mine location is greater than 2.5 miles from the boundary of the wilderness (assuming there is no wind or obstruction). Unless there is a high ground in the wilderness there will, probably not be any visual impact, especially if there is surrounding vegetation. 3. There have been, and continue to be, impacts to the wilderness due to livestock grazing, recreation, OHV use, vegetation and wildlife restoration, trail and road construction, tourism in adjacent parks and monuments, drought and wildfires, and other activities. Why is a temporary (about 5 years) impact from uranium mining so intolerable? Does this justify the removal of 1 + million acres of land from mining under Alternative B, or even the smaller amounts under Alternatives C and D? 4. It should not be forgotten that each new mine would be the subject of its own site specific EIS and the NEPA process.	Section 3.14 and 4.14, Wilderness Characteristics.
Northwest Mining Association	225275	6	Importantly, the lands in question have already undergone evaluation and decision for withdrawal. In the 1980's, the uranium industry, government and environmental groups agreed on the terms of the Arizona Strip Wilderness Protection Act of 1983, which became law in 1984.	The purpose of this FEIS is not to rescind, re-evaluate or interpret the 1984 Arizona Wilderness Act. The FEIS analyzes the potential impacts a 20-year withdrawal would have on the natural and human environment to enable the Secretary to make a decision. The FEIS includes information on the 1984 Arizona Wilderness Act in Sections 1.4.3, Authorities, and 3.13, Wilderness Resources. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses.
Arizona Rock Products Association	242654	6	In 1984, Arizona's Congressman Morris Udall, as Chairman of this Committee, directed the uranium mining industry, native Americans, environmentalists, cattlemen and other stakeholder groups to negotiate an agreement on which lands should be left open for mining and other multiple use activities and which lands should be designated wilderness. Those groups met and negotiated a compromise which formed the basis for designating Arizona's first wilderness areas as buffer zones around the Grand Canyon National Park. Chairman Udall together with Arizona's Senator Barry Goldwater, Senator Dennis Deconcini, and his House colleagues John McCain, and Bob Stump honored the negotiated	The text of the FEIS has been changed in response to this concern. The FEIS includes information on the 1984 Arizona Wilderness Act in Sections 1.4.3, Authorities, and 3.13, Wilderness. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			agreement and released these very same lands now proposed for withdrawal from Wilderness Study classification with the specific understanding and expectation that uranium mining would occur on them under the strict environmental laws of both the State of Arizona and federal government.	
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	52	The DEIS assumes that any disturbance to the Designated Wilderness and NPS Wilderness areas would be limited to only 1-5 years. This is based on a false model of a limited number of mining sites where the site was mined and remediated in a limited time period. In fact, most of the uranium mine sites in the Grand Canyon ecoregion and Arizona Strip have a record of extended mining of over 20 years with on and off periods of activity. In the meantime, the mining equipment, facility and access roads exist without any remediation. Secondly, by opening any area up to more exploration, there will be continuous activity of equipment, drilling, and road/access building with substantial impairment of the wilderness characteristics of the area forever. Additionally, exploration of an area will not likely be limited to a 1-5 year period. Past experience has demonstrated that exploration will come in waves and be both in the form of land-based travel and helicopter transport of equipment and personnel.	The text of the FEIS has been changed in response to this concern by revising the text in Section 4.13.3 to state. In addition, clarifying language has been added to Section 4.13, Wilderness which directs the reader that impacts to wilderness characteristics are analyzed in detail in another Section of the FEIS: 4.14 Wilderness Characteristics. The assumptions included in Section 4.14, Wilderness Characteristics state that new mines would be subject to their own site-specific NEPA analysis in support of a Mining Plan of Operation, and further NEPA and revised Mining Plans of Operations would be required if the mine exceeds the 1-5 year limitation. The RFD-scenarios presented in Appendix B of the DEIS describe the assumptions for analysis for mining and mining-related activities, including identifying the anticipated timeframes of facilities.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	53	The DEIS assumes that any disturbance to the Designated Wilderness and NPS Wilderness areas would be limited. However, each 20 acres of mine footprint would negatively impact the wilderness characteristics of many square miles of land. These impacts from the activities associated with uranium mining include noise, visual impairment, dust, truck traffic, secondary traffic and OHV use resulting from new road access, low flying aircraft and disturbance to wildlife. All of these would seriously detract from the outstanding opportunities for solitude and enjoyment of a primitive area over a broad landscape.	The FEIS has been revised in Section 4.13.3, Wilderness Direct and Indirect Impacts to state, “Mining activities that would occur under a no-withdrawal scenario that are far from designated or proposed wilderness would have a minor short-term impact to wilderness resources. Mining activities in close proximity to designated or proposed wilderness boundaries would have a moderate short-term impact to the wilderness resources of naturalness, opportunities for solitude, and opportunities for primitive and unconfined recreation.” The ASFO RMP identifies 12,848 acres of lands managed to maintain wilderness characteristics within the Proposed Withdrawal area; the FEIS has been updated to include existing conditions and analysis of impacts to BLM, Forest and NPS wilderness characteristics in Section 3.14 and 4.14, Wilderness Characteristics. New mines would be subject to their own site-specific NEPA analysis in support of a Mining Plan of Operation. BLM lands allocated in the Arizona Strip RMP of 2008 that are managed to maintain wilderness characteristics are not withdrawn lands nor are they

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
				managed the same as Congressionally designated wilderness (see EIS Section 4.14 for further detail.) The RFD-scenarios presented in Appendix B of the DEIS describe the assumptions for analysis for mining and mining-related activities, including identifying the anticipated timeframes of facilities.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	54	Since noise and visual impacts cross political boundaries, all wilderness areas in close proximity to the Parcels can be impacted by mine noise. Table 4.10-6 identifies the distance that mining operations are audible as 30 km (18.6 miles) from the sound source. Mt. Trumbull Wilderness and Mt. Logan Wilderness are approximately 5 and 10 miles from the North Parcel and may be subject to noise impacts just as Saddle Mountain Wilderness, Kanab Creek Wilderness, and Paria Canyon-Vermilion Cliffs Wilderness are. Aerial exploration will harass visitors to Wilderness areas. As mentioned under the Soundscapes section of this document, potential noise impacts to Wilderness Areas must be acknowledged.	Sound and visual impacts to wilderness areas would be minimized in a Mining Plan of Operations for mines within proximity to wilderness areas or lands managed to maintain wilderness characteristics, as discussed in Section 4.10, Soundscapes, of the DEIS. Mount Trumbull and Mount Logan Wilderness areas are included in the wilderness resources analysis as an indirect impact in the FEIS in Section 4.13, Wilderness Resources; in addition, potential noise impacts area discussed in Section 4.13.3, Direct and Indirect Impacts.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	55	Visual impacts from exploration and mine operations will also harm Wilderness Areas. In remote Wilderness Areas with truly dark skies, such as the five that are proximal to the Withdrawal Area, isolated lights on mine structures will draw visitors' attention, ruining the untrammeled and undeveloped character of the landscape. As mentioned under the Visual Resources section of these comments, elevated topographic features within Wilderness such as cliff faces and hills enable views far across the landscape. Linear features such as roads and power lines are difficult to mask and will damage the wilderness character of designated and proposed wilderness areas.	Sound and visual impacts to wilderness areas would be minimized in a Mining Plan of Operations for mines within proximity to wilderness areas or lands managed to maintain wilderness characteristics, as discussed in Section 4.10, Soundscapes, and 4.9, Visual Resources, of the DEIS.
Grand Canyon Wildlands Council, Grand Canyon Trust, Sierra Club - Grand Canyon Chapter, Center for Biological Diversity	225279	56	Anthropogenic activities involving manipulation of vegetation and soils, such as mining and road building, leave a permanent reminder of human influence in otherwise untrammeled and undeveloped areas. Arizona soils tend to be covered by thin topsoil layers and/or biological soil crusts, which concentrate in the top 3 mm of soils and take decades to begin recovery after disturbance (Belnap and Gillette 1997, Belnap and Gillette 1998). Once soil crusts or topsoil are damaged, site productivity is reduced and erosion is enhanced, inhibiting a return to a natural state. The DEIS states that the Wilderness Areas proximal to the Withdrawal Area, protected as designated Wilderness for 26 years, *contain little to no evidence of surface disturbance, other than former vehicle ways and scattered prospects*(DEIS p. 3-214, emphasis added). This is evidence that temporary roads, overland routes, exploratory activities, and mines leave permanent scars on the landscape and should be considered incompatible with proposed Wilderness and viewsheds from proposed and designated Wilderness.	The Arizona Wilderness Act of 1984 precludes management of a buffer zone or viewshed buffer of any type for the wilderness areas within the Arizona Strip and Kaibab National Forest. NPS Management Policies developed in 2006 (NPS Management Policies, August 31, 2006, Section 1.6) address wilderness management as well as management of outside threats to park resources. Any new Mining Plan of Operations within the lands open to mineral entry would require site-specific NEPA analysis prior to approval.
Frank Bain	242677	3	The issue of the newly proposed area for withdrawal was supposedly	The text of the FEIS has been changed in response to

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			settled back in the 1984 when the Arizona Strip Wilderness Act was passed, an agreement with the USFS, BLM, mining companies, and other interested groups where a large portion of land on the North Rim was withdrawn from mineral entry and that the remaining lands outside of this withdrawal would remain open for exploration and mining. Why is government attempting to renege on this agreement? Why was this agreement and issue not mentioned in the EIS?	this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses.
Quaterra Resources, Inc.	242664	7	The EIS is strangely silent on a number of issues germane to a decision on whether to withdraw these lands from mineral exploration and development, and more importantly would give an uninformed reader a sense of perspective and balance. These issues include the 1984 Wilderness act which set aside this area for multiple use activities based on the best science of the day and participation by both industry and environmental groups	The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses.
The NAU Project, LLC	242913	23	*Designated wilderness is already withdrawn. However, mining adjacent to Wilderness Areas could affect the wilderness characteristics of these lands, including lands managed as wilderness in Grand Canyon National Park.* The Arizona wilderness Act of 1984 section (d) allows mining and other multiple use activities right up to the boundary of the wilderness and does not allow buffers to be created due to the effects of these activities. SEE comments and annotations in various other places in my commentary. The whole concept of the effects on wilderness needs to be re-thought in light of the AWA of 1984 section (d) and a justification provided for including a wilderness section if that is what is finally decided.	The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses.
The NAU Project, LLC	242913	29	Page 3-9 Table 3.1-1 3.13 Wilderness Resources This resource category should not be used in this EIS. The Arizona Wilderness Act of 1984 at part (d) says: *The Congress does not intend that designation of wilderness areas in the State of Arizona lead to the creation of protective perimeters or buffer zones around each wilderness area. The fact that nonwilderness activities or uses can be seen or heard from areas within a wilderness shall not, of itself, preclude such activities or uses up to the boundary of the wilderness area.* This section of the law indicates that activities outside the wilderness area are not to be used as affects on the wilderness area that requires some protective act. This DEIS is supposing that there might be effects from the mining of uranium for which the wilderness area will need to be protected from. This is in opposition to the Arizona Wilderness Act of 1984 and the sections and references in this DEIS and final EIS that pertain to Wilderness affects should be deleted in whole.	The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses.

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
The NAU Project, LLC	242913	34	Section 3.13.1 Wilderness The introduction to this section should include the Arizona Wilderness Act of 1984 Public Law 98-406 and state the pertinent special management instructions that Congress included: *(d) The Congress does not intend that designation of wilderness areas in the State of Arizona lead to the creation of protective perimeters or buffer zones around each wilderness area. The fact that nonwilderness activities or uses can be seen or heard from areas within a wilderness shall not, of itself, preclude such activities or uses up to the boundary of the wilderness area.* The withdrawal areas on the North and East parcels would be the buffer zones created should these areas be withdrawn. If the affects on the wilderness areas were a part of the decision making process for the withdrawal then that would be against the intent and will of Congress which has specifically prohibited this consideration by an act of Law.	The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities, of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses. The Northern Arizona Proposed Withdrawal only pertains to locatable minerals. This withdrawal would still allow for other development such as roads, timber sales, leasable minerals, right of ways, etc.
The NAU Project, LLC	242913	71	Section 4.13 Wilderness The introduction to this section should include the Arizona Wilderness Act of 1984 Public Law 98-406 and state the pertinent special management instructions that Congress included: *(d) The Congress does not intend that designation of wilderness areas in the State of Arizona lead to the creation of protective perimeters or buffer zones around each wilderness area. The fact that nonwilderness activities or uses can be seen or heard from areas within a wilderness shall not, of itself, preclude such activities or uses up to the boundary of the wilderness area.* The withdrawal areas on the North and East parcels would be the buffer zones created should these areas be withdrawn. If the affects on the wilderness areas were a part of the decision making process for the withdrawal then that would be against the intent and will of Congress which has specifically prohibited this consideration by an act of Law.	The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses.
Navajo Nation Department of Justice	225264	2	The Navajo Nation would like to also state its Fundamental Position remains that there will be no uranium mining or processing within the Navajo Nation, until our expressed concerns have been adequately addressed. The Navajo Nation concerns regarding Uranium Mining and Processing have been codified in the Dine' Natural Resources Protection Act of 20 OS, CAP-18-05; and have been provided in testimony to the U.S. House of Representatives, Committee on Oversight and Government Reform, Hearing on the Legacy of Uranium Mining Impacts on the Navajo Nation," October 2007.	The DEIS includes a discussion of stakeholder values, including the position of the Navajo Nation (see pages 3-241-3-242). Additionally, the 2007 Hearing testimony is cited in this text. The EIS analyzes the Proposed Action and Alternatives of withdrawal from the Mining Law of 1872 on BLM and National Forest Lands. Actions on the Navajo Nation are outside the scope of this EIS.
Washington County Commission	225251	2	Arizona Strip Wilderness Act of 1983 - This landmark legislation defined areas that were to be put into the National Wilderness Preservation System. It also included areas that were to remain open to mineral entry for uranium mining in the Grand Canyon area. The Wilderness Act is not included or referenced anywhere in the DEIS. Washington County was one of the local governments that, together with mining companies, environmental groups, grazers, local businesses, regulatory agencies and Congress, forged the compromise which led to its ultimate passage. The	The Proposed Withdrawal does not supersede the purpose of the 1984 Arizona Wilderness Act. The "release" component of the 1984 Act also does not preclude mineral entry to non-wilderness lands, it "releases certain lands not designated as wilderness for such management as is determined appropriate throughout the land management planning process of the administering agency." The intent of Congress

Table 5.6-4. Response to Comments (Continued)

Organization	Letter Submittal No.	Comment No.	Comment Text	Response
			wilderness bill created 387,000 acres of BLM/USFS wilderness and released 540,000 acres. Most of the acres that were released are now within the 1 million-acre proposed withdrawal area. The unilateral withdrawal by the secretary would undermine the intent of the Congress and the legislation they passed which was signed into law by then President Ronald Reagan.	would not be undermined as the Proposed Withdrawal would not redesignate any Wilderness areas. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses. The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources.
San Juan County Commission	243250	8	The Arizona Strip Wilderness Act of 1983 was important legislation in which specific areas were put into the National Wilderness Preservation System. At the same time, other specific areas within the Arizona Strip were to remain open to mineral mining. Nowhere in the DEIS is this mentioned or included in the document. The Act was approved by the Congress of the United State of America, not by a burecratic federal agency. The aspects of uranium and its industry were studied and considered at the time that Congress acted and approved the Wilderness Act of 1983 in which Congress felt strong enough to release these lands to mining activities.	The Proposed Withdrawal does not supersede the purpose of the 1984 Arizona Wilderness Act. The "release" component of the 1984 Act also does not preclude mineral entry to non-wilderness lands, it "releases certain lands not designated as wilderness for such management as is determined appropriate throughout the land management planning process of the administering agency." The intent of Congress would not be undermined as the Proposed Withdrawal would not redesignate any Wilderness areas. The language in the 1984 Arizona Wilderness Act releasing lands in the Arizona Strip BLM and the Kaibab National Forest from wilderness review by Congress did not preclude future reviews for wilderness or other conservation uses. The text of the FEIS has been changed in response to this concern. The 1984 Arizona Wilderness Act is included in Section 1.4.3, Authorities of the FEIS. The FEIS also includes information on the 1984 Arizona Wilderness Act in Section 3.13, Wilderness Resources.

5.7 LIST OF PREPARERS

This EIS was prepared and reviewed by a team from the BLM and Forest Service. A team associated with SWCA Environmental Consultants (SWCA) assisted the BLM and Forest Service in conducting research, gathering data, and preparing the EIS and supporting documents. Table 5.7-1 identifies team members and their roles.

5.7.1 Interdisciplinary Team Members

Table 5.7-1. List of Preparers

Organization	Name	Qualifications	Project Role
BLM	Chris Horyza	B.S. Forestry and Range Management	Project Manager/Arizona State Office Planning and Environmental Coordinator
BLM	Scott Haight	B.S. Geology	Project Manager
BLM	Scott Florence	B.S. Range and Wildlife	Arizona Strip District Manager
BLM	Lorraine Christian	B.S. Wildlife and Fisheries Biology	Arizona Strip Field Manager
BLM	Todd Calico	B.I.S. Natural Resources and Environmental Studies	Cartographic Technician
BLM	Rody Cox	B.A. Molecular, Cellular, and Developmental Biology M.S. Earth Sciences	Geologist/Mineral Specialist
BLM	Jim Fogg	M.S. Watershed Science	Hydrologist
BLM	Jeff Garrett	B.S. Geology	Mining Law Program Lead
BLM	Diana Hawks	B.S. Archaeology M.S. Archaeology	District Recreation, Wilderness, and Cultural Resources Team Lead
BLM	John Herron	B.A. Archaeology (minor in Ecology and Evolutionary Biology)	Archaeologist
BLM	Lee Hughes	B.S. Fisheries and Range Management	Ecologist
BLM	Tim Hughes	B.S. Wildlife Biology	Threatened and Endangered Species Program Lead, Arizona State Office
BLM	Jon Jasper	M.S. Geosciences	Outdoor Recreation Planner
BLM	Michael Johnson	B.S. Anthropology M.S. Anthropology	Deputy Preservation Officer
BLM	Joel Larson	B.A. Geography M.P.P. Master of Public Policy	Social Science Program Analyst
BLM	Brent Lewis	B.A. Geology B.S. Environmental Science M.S. Geology	Human Toxicologist
BLM	Paul McNutt	B.S. Environmental Science M.S. Economics	Economist
BLM	Craig Nicholls	B.S. Atmospheric Sciences M.S. Atmospheric Sciences	National Air Quality Modeler
BLM	Darla Pindell	B.A. Economics and Accounting M.B.A. Business Administration	Socioeconomist
BLM	Jeff Simms	M.S. Wildlife and Fisheries Science B.S. Fisheries Science	Fisheries Biologist
BLM	Bob Smith	B.S. Plant, Soil, and Water Science Graduate Certificate, Hazardous Waste Land Management	Soil, Water and Air Specialist

Table 5.7-1. List of Preparers (Continued)

Organization	Name	Qualifications	Project Role
BLM	Richard Spotts	B.A. Political Science J.D. Law	Planning and Environmental Coordinator
BLM	Connie Stone	Ph.D. Anthropology	Archaeologist
BLM	Joan Trent	M.S. Environmental Science	Sociologist
Forest Service	Liz Schuppert	B.S. Forest Management	Kaibab National Forest Recreation, Lands and Minerals Staff Officer
Forest Service	Alvin Brown	B.S. Forestry	Kaibab National Forest NEPA Coordinator
Forest Service	Roger Congdon	B.S. Geology M.S. Geology Ph.D. Geology	Groundwater Geologist, Southwestern Region of the Forest Service
Forest Service	Angela Gatto	B.S. Biological Sciences M.S. Forestry	Wildlife Biologist, North Kaibab Ranger District
Forest Service	Margaret Hangan	B.A. Anthropology M.A. Anthropology	Kaibab National Forest Heritage Program Manager
Forest Service	Mike Hannemann	B.S. Wildlife Biology M.S. Forestry	Kaibab National Forest Range and Watershed Staff Officer
Forest Service	Christopher MacDonald	M.S. Forest Science	Kaibab National Forest Soil Scientist
Forest Service	Mark Schwab	B.A. Geological Sciences	Certified Mineral Examiner, Southwestern Region of the Forest Service
Forest Service	Diane Tafoya	B.A. Geology	Zone Geologist and Certified Mineral Examiner, Cibola/Kaibab National Forests
Forest Service	Richard Periman	B.A. Anthropology/History M.S. Anthropology Ph.D. Environmental Science and Technology	Social Science Coordinator, Southwestern Region of the Forest Service
Forest Service	Michael Linden	B.S. Geology M.S. Economic Geology	Certified Mineral Examiner, Regional Liaison for Centralized National Operations, Minerals and Geology Management
Forest Service	Jessica Lopez-Pearce	B.S. Geosciences M.S. Earth and Planetary Sciences	Geologist, Kaibab National Forest
SWCA	Ken Houser	M.A. Geology	Managing Principal
SWCA	Charles Coyle	M.A. English	Project Manager
SWCA	Jill Grams	M.L.A. Landscape Architecture	Assistant Project Manager/Visual Resources Specialist
SWCA	Molly Thrash	B.A. Anthropology	NEPA Planner
SWCA	Chris Garrett	B.S. Hydrology	Geology and Minerals Specialist
SWCA	Tom Furgason	B.S. Ecology and Evolutionary Biology	Senior Biologist
SWCA	Ken Kertell	M.S. Wildlife Biology	Wildlife Biologist
SWCA	Mark Turner	M.S. Biology	Wildlife Biologist
SWCA	Amanda Kuenzi	M.S. Forestry	Vegetation Specialist
SWCA	Greg Seymour	M.A. Archaeology	Archaeologist
SWCA	Adrienne Tremblay	Ph.D. Anthropology	Archaeologist
SWCA	Annmarie Kmetz	M.A. Heritage Resources	Archaeologist
SWCA	Victor Villagran	B.A. Anthropology	Archaeologist
SWCA	Megan Robertson	B.S. Public Planning	Land Use/Public Involvement Specialist

Table 5.7-1. List of Preparers (Continued)

Organization	Name	Qualifications	Project Role
SWCA	Ryan Rausch	M.E.L.P. Environmental Law	Recreation Specialist
SWCA	Jeff Connell	M.A. Public Administration	Socioeconomics Specialist
SWCA	Cara Bellavia	M.U.E.P. Master of Urban and Environmental Planning	Socioeconomics Specialist
SWCA	Christina White	M.P.P. Master of Public Policy	Socioeconomics Specialist
SWCA	Glenn Dunno	M.A. Geography	GIS Coordinator
SWCA	Chris Query	B.S. Natural Science and Geography	GIS Specialist
SWCA	Heidi Orcutt-Gachiri	Ph.D. Linguistics and Anthropology	Senior Technical Editor
SWCA	Danielle Desruisseaux	B.A. Anthropology	Technical Editor/Archaeologist
SWCA	Peggy Ford	B.A. English and Chemistry	Technical Editor
SWCA	Paige Marchus	B.A. Journalism	Technical Editor
SWCA	Camille Ensle	B.A. Studio Art (in progress)	Publication Specialist
SWCA	Jessica Maggio	B.A. Anthropology/Photography	Publication Specialist
SWCA	Elizabeth Slocum	B.A. Sociology	Publication Specialist
SWCA	Michelle Weigman	B.S. Art	Graphic Design Specialist
SWCA	Benjamin Gaddis	M.A.T. General Science M.E.M. Water and Air Resources	NEPAPublic Facilitation Specialist
SWCA	Ryan Van Wormer	N/A	Public Involvement Specialist
SWCA	Donna Morey	B.I.S. Urban Planning (in progress)	Project Administrator
SWCA	Kimberly Proa	A.A. Anthropology	Project Administrator
SWCA	David Reinhart	B.A. Anthropology	Website Developer
SWCA	Sarah Wilcox	B.A. Anthropology	Database Specialist
Rozelle Group	Marty Rozelle	Ph.D. Community Education	Public Involvement
Montgomery & Associates	William Victor, P.G.	M.S. Hydrology	Water Resources / Soil Resources
Montgomery & Associates	Andrew Scott, P.G.	M.S. Geology	Water Resources / Soil Resources
Ninyo & Moore	Bill Jamieson	B.S. Zoology	Air Quality / Soundscapes
Ninyo & Moore	Al Ridley	M.S. Geology	Air Quality / Soundscapes
Ninyo & Moore	Bradley Sohm	B.S. Chemical Engineering	Air Quality / Soundscapes
Ninyo & Moore	Sandra Ripplinger	B.S. Occupational and Environmental Health and Safety	Air Quality / Soundscapes
Ninyo & Moore	Mark A. Williams	B.S. Environmental Science and Biology	Air Quality / Soundscapes
BBC Research and Consulting	Doug Jeavons	M.A. Economics	Economic Analysis
BBC Research and Consulting	Mollie Fitzpatrick	M.A. Economics	Economic Analysis
N/A	Clark Lantz	Ph.D. Physiology and Biophysics	Environmental Toxicology
N/A	John Loomis	Ph.D. Economics	Economic Valuation of Non-Market Natural Resources

5.8 COOPERATING AGENCY TEAM

In addition to the specialists identified in Table 5.6-1, who were actively engaged in developing the Draft EIS, numerous specialists from the cooperating agencies contributed their expertise by reviewing and submitting comments on the EIS as it evolved. These agencies and individuals are identified in Table 5.8-1.

Table 5.8-1. Cooperating Agency Reviewers

U.S. Forest Service			
Mike Williams	Angela Parker	Charlotte Minor	Jackie Banks
Roy Jemison	Anna Jaramillo		
National Park Service			
Martha Hahn	Jan Balsom	RV Ward	Linda Jalbert
Kirstin Heins	Steve Rice	Shannon Reed	Lori Makarick
Jane Rodgers	Kerry Moss	Chris Turk	Deanna Greco
John Notar	Jerry Mitchell	Cal McCusker	Tim Bowden
U.S. Fish and Wildlife Service			
Brenda Smith	Brian Wooldridge	Bill Austin	
U.S. Geological Survey			
John Hoffman	Andrea Alpine	Don Bills	Jim Otton
Jo Ellen Hinck			
Arizona Game and Fish Department			
Andi Rogers	Ron Sieg		
Arizona Geological Survey			
Lee Allison	Jon Spencer	Jeri Young	
Arizona State Land Department			
Joe Dixon			
Arizona Department of Mines and Mineral Resources			
Madan M. Singh			
Arizona Department of Environmental Quality			
Debra Duerr			
Kaibab-Paiute Tribe			
LeAnn Skrzynski	Glendora Homer		
Hualapai Tribe			
Peter Bungart	Alex Cabilla	Loretta Jackson-Kelly	
Mohave County, Arizona			
Cindy Levesque	Cullin Pattillo	Gary Watson	
Coconino County, Arizona			
Bill Towler			

Table 5.8-1. Cooperating Agency Reviewers (Continued)

San Juan County, Utah			
Rick Bailey	David Gallegos	Jerry McNeely	Bruce Adams
Kane County, Utah			
Daniel Hulet			
Washington County, Utah			
Alan Gardner	Ron Whitehead	Dean Cox	

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Chapter 6

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Chapter 7

GLOSSARY

100-year flood. A flood event of such magnitude that it occurs, on average, every 100 years. This equates to a 1% probability of occurring in any given year.

Affected environment. The existing biological, physical, social, and economic conditions of an area that are subject to change, both directly and indirectly, as a result of a proposed human action.

Acre-foot. A measure of volume of water. The amount of water it would take to cover 1 acre of land to a depth of 1 foot; equal to 325,851 gallons or 43,560 cubic feet.

Air quality. The cleanliness of the air as measured by the levels of pollutants relative to standards or guideline levels established to protect human health and welfare.

Ambient concentration. The mass of a pollutant in a given volume of air, typically measured as micrograms of pollutant per cubic meter of air.

Animal unit month. Amount of forage required to sustain a cow/calf unit (one cow and one calf) or equivalent for one month.

Aquifer. A water-bearing body of permeable rock, sand, or gravel. A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to conduct groundwater and yield quantities of water to wells and springs.

Area of Critical Environmental Concern. A Bureau of Land Management designation for an area within public lands in which special management is required in order to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes, or to protect life from natural hazards.

Assessment (environmental). An evaluation of existing resources and potential impacts to those resources from a proposed act or change to the environment.

Attainment area. A geographic region that meets the National Ambient Air Quality Standards for a criteria pollutant under the Clean Air Act.

Background concentration. The existing levels of air pollutant concentration in a given region. In general, it includes natural and existing emission sources but not future emission sources.

Baseline. The environmental conditions that form the basis against which the environmental consequences of a proposed action are evaluated.

Best management practices. Structural and operational measures undertaken to reduce erosion and sedimentation before beginning and continuing during ground-disturbing activities. Best management practices are measures that are demonstrated to be the best available for the site for controlling soil loss and protecting water quality, given the site-specific social, economic, and technical constraints.

Breccia pipe. A narrow, vertical geological structure formed by the collapse of a cavity in an underlying limestone formation, typically filled with breccia, which is a rock formed of debris from the overlying geological formation.

Candidate species. Species for which the U.S. Fish and Wildlife Service has sufficient information on file regarding biological vulnerability and threat(s) to support the issuance of a proposed rule to list the species as threatened or endangered but for which issuance of the proposed rule is precluded.

Code of Federal Regulations. The compilation of federal regulations adopted by federal agencies through a rule-making process.

Cooperating agency. A federal, state, or local government entity that provides input for and review of the compliance process required by the National Environmental Policy Act of 1969 but that is not responsible for management of that process.

Core area. A component of natural habitat composed of "contiguous blocks of uniform habitat types away from natural breaks or habitat edges,"[24] used to describe the inner part of the effect zone.

Council on Environmental Quality. An advisory council to the President of the United States established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Criteria pollutants. Air pollutants for which the U.S. Environmental Protection Agency has established National Ambient Air Quality Standards. These include particulate matter, nitrogen oxides, sulfur dioxide, carbon monoxide, and volatile organic compounds.

Cultural resources. Areas, properties, or sites of importance to cultural groups. In addition to areas of importance for traditional uses or products, these include the remains of human activity, occupation, or endeavor, as reflected in districts, sites, buildings, objects, artifacts, ruins, works of art, architecture, and natural features important in human events.

Cumulative effects. The impact on the environment that results from the incremental effect of the Proposed Action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions that take place over a period of time.

Direct effect. See *Direct impact.*

Direct impact. Beneficial or adverse effect that is caused by an action and occurs at the same time and place.

Distance zones. A subdivision of the landscape as viewed from an observer position. The subdivision (zones) includes foreground–middle ground, background, and seldom seen.

Drill site. A location, typically cleared of vegetation, at which a drill rig is placed and a vertical hole is drilled downward in order to collect geological samples and determine the presence of economic minerals.

Ecotone. The transition zone between two major ecological communities in which one does not merge gradually into the other, for example, that between grassland and woodland.

Edge area. The portion of wildlife habitat that forms the borders with nearby non-habitat area and typically provides less value to wildlife.

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[24] Weller, C., J, Thomson, P. Morton, and G. Aplet, 2002. *Fragmenting Our Lands: The Ecological Footprint from Oil and Gas Development—a Spatial Analysis of a Wyoming Gas Field.* Seattle, Washington, and Denver, Colorado: The Wilderness Society. Available at: <http://wilderness.org/files/fragmenting-our-lands.pdf>.

Effect. See *Impact.*

Emission. Discharge of pollutants into the atmosphere, usually specified by mass of pollutant per unit of time.

Endangered species. A plant or animal species that is threatened with extinction or serious depletion in its range and is formally listed as such by the U.S. Fish and Wildlife Service.

Environmental Impact Statement. A document prepared to analyze the impacts on the environment of a Proposed Action and released to the public for review and comment. An Environmental Impact Statement must meet the requirements of the National Environmental Policy Act and the Council on Environmental Quality and the directives of the lead federal agency responsible for the Proposed Action.

Endemic environment. Plants or animals that are native to a particular region; the surrounding conditions, influences, or forces that affect or modify an organism or an ecological community and ultimately determine its form and survival.

Ephemeral stream. A stream or portion of a stream that flows only in direct response to precipitation.

Evapotranspiration. The loss of water from the soil both by evaporation and by transpiration from the plants growing there.

Fault. A fracture or fracture zone in the earth's surface along which there has been displacement of the sides relative to one another and parallel to the fracture.

Federally listed threatened and endangered species. Species afforded protection under the Endangered Species Act. An endangered species is one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered in the foreseeable future.

Floodplain. The portion of a river or stream valley, adjacent to the river channel, that is made up of stream sediments and is inundated with water when the stream overflows its banks.

Forage. All browse and herbaceous foods available to grazing animals for feeding.

Fragmentation. See *Habitat fragmentation*.

Groundwater recharge. Water that infiltrates the land surface and is not lost to evaporation or consumed by plants can percolate downward and replenish groundwater aquifers. This deep percolation is called recharge.

Habitat. The region in which a plant or animal naturally grows or lives. A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

Habitat fragmentation. The disruption (by division) of habitat into smaller habitat patches. The effects of habitat fragmentation include loss of habitat area, increased edge area, and the creation of smaller, more isolated patches of remaining habitat.

Habitat type. A habitat type is the basis of a forest ecosystem classification system. It is an aggregation of all land areas potentially capable of producing similar plant communities at climax. Habitat types are usually named for the most shade-tolerant tree species that will grow on the site and an understory plant that is represented with a high degree of constancy.

Haul road. The route over which mined ore is moved from the mine to a processing location or waste rock is moved to a storage location.

Hazardous waste. Waste that is designated hazardous by the U.S. Environmental Protection Agency or state regulations. As defined under the Resource Conservation and Recovery Act, hazardous waste is waste from production or operation activities that poses a potential hazard to human health or the environment when improperly treated, stored, or disposed of. Hazardous waste that appears on special U.S. Environmental Protection Agency lists or possesses at least one of the four following characteristics: ignitability, corrosivity, reactivity, or toxicity.

Head structure. The frame and equipment built above a vertical mine shaft in order to raise ore from the mine and lower personnel and equipment into the mine.

Human environment. The natural and physical environment and the relationship between people and the environment.

Hydrology. A science that studies the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere.

Impact. The terms "impacts" and "effects" are synonymous as used in National Environmental Policy Act analyses. Impacts may be beneficial or adverse and may apply to the natural, aesthetic, historic, cultural, and socioeconomic resources of the installation and the surrounding communities. Where applicable, impacts may be classified as direct or indirect.

Indicator species. A wildlife species whose presence in a certain location or situation at a given population level indicates a particular environmental condition. Population changes are believed to indicate effects of management activities on a number of other wildlife species.

Indirect effect. See *Indirect impact.*

Indirect impact. An indirect impact is caused by a proposed activity but is later in time or farther removed in distance while still being reasonably foreseeable. Indirect impacts may include land use changes or population density changes and the related effects these changes will have on air, water, and other natural or social systems.

Infiltration. Water that falls on the land surface and does not run off. Some of this water evaporates, some is used by plants, and some percolates downward to the groundwater.

Interim management (a mine under interim management). A mine operating under alternate stipulations under an approved mine plan of operations during periods when ore is not being removed because of temporary changes in economic or regulatory conditions.

Intermittent stream. A stream that flows only at certain times when it receives water from springs or from a surface source.

Leasable mineral. Minerals that may be acquired under the Mineral Leasing Act of 1920, as amended, including coal, oil shale, oil and gas, phosphate, potash, sodium, and geothermal resources.

Listed species. Any species that occurs on a threatened or endangered species list at the state or federal level.

Lithic. Pertaining to stone or a stone tool (e.g., lithic artifact).

Lithic scatter. An archaeological site type characterized by a surface scatter of artifacts that consists entirely of lithic (i.e., stone) tools and chipped stone debris.

Locatable materials. Traditional hardrock minerals, such as gold, silver, lead, copper, and zinc, and industrial minerals, such as fluorspar, barite, and high-calcium limestone, that occur in lode or placer deposits. Lode claims are located on indurated bedrock, whereas placer claims are usually located on loosely consolidated materials, such as mineral-bearing sands and gravels.

Long-term impacts. Long-term impacts are neither temporary nor reversible. They may occur either during the construction or operation phases of an activity. For example, the construction of a new building may create long-term impacts during both the construction and operation phases. Draining of a wetland for the construction of a new building will create long-term and permanent impacts to biological resources. Likewise, once in operation, the new building may create additional long-term impacts such as increased population density, waste generation, etc.

Mine footprint. The land area within which all surface mining activities are conducted, including head structures for underground mines, stockpiles of waste rock or ore, and stormwater or process water basins.

Mine plan of operations. A description of proposed mineral exploration or mining, including the name and address of the operator, location of the operation, access to the operation, period in which the operation would take place, and other information, as required by the Bureau of Land Management in accordance with 43 CFR Part 3809 and by the U.S. Forest Service in accordance with 36 CFR Part 228.4.

Mineral entry. Authority to enter public lands for the purpose of developing minerals in an orderly, organized manner.

Mineral rights. An ownership interest in minerals that may or may not be owned by the person or party having title to the surface estate.

Mineralized breccia pipe. A breccia pipe in which, over time, various minerals have formed in fractures and pores as a result of the presence of mineral-rich groundwater, some of which may be economic to mine for uranium and other metals.

Mitigation. Actions intended to render an action less severe or harmful to environmental resources. Mitigation generally includes the following: avoiding the impact altogether by stopping or modifying the Proposed Action; minimizing impacts by limiting the degree or magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by conducting preservation and maintenance operations during the life of the action; compensating for the impact by replacing or providing substitute resources or environments.

National Ambient Air Quality Standards. Section 109 of the Clean Air Act requires the U.S. Environmental Protection Agency to set nationwide standards for widespread air pollutants. Currently, six pollutants are regulated: sulfur dioxide, carbon monoxide, particulate matter 10, nitrogen dioxide, ozone, and lead.

National Register of Historic Places. A listing of architectural, historical, archaeological, and cultural sites of local, state, or national significance established by the National Historic Preservation Act of 1966 and maintained by the National Park Service.

No Action Alternative. The most likely condition expected to exist in the future if current management direction were to continue unchanged.

No effect. See *No impact.*

No impact. "No impact" implies that a particular activity creates neither a direct nor indirect impact, does not have long- or short-term implications, and is neither beneficial nor negative.

Nonattainment area. An area that has been designated by the U.S. Environmental Protection Agency or the appropriate state air quality agency as exceeding one or more national or state Ambient Air Quality Standards.

Nonpoint source. Source of pollution generally attributed to urban runoff from irrigating landscapes and golf courses, draining pools to streets, washing vehicles in streets, and hosing down driveways.

Noxious weed. An undesirable weed species that typically moves into disturbed areas, grows aggressively, and outcompetes desirable or native species for resources.

Off-highway vehicle. Any motorized vehicle designated for cross-country travel over any type of natural terrain.

Ore. Naturally occurring material from which a valuable mineral or minerals can be economically extracted.

Overburden. Rock and soil cleared away prior to mining.

Ozone (ground level). A major ingredient in smog. Ozone is produced from reactions of hydrocarbons and nitrogen oxides in the presence of sunlight and heat.

Particulate. Fine liquid or solid particles, such as dust, smoke, mist, fumes, or smog, found in air or emissions.

Particulate matter. Particulate matter is regulated under the Clean Air Act. Particulate matter 10 is particulate matter that is 10 microns or less in effective diameter (also called fine particulate matter). Particulate matter 2.5 is particulate matter that is 2.5 microns or less in diameter.

Patent. A document by which the United States conveys, to those entitled thereto, legal title to some portion of the public lands (Glossaries of Bureau of Land Management Surveying and Mapping Terms).

Patented claims. Private land that has been secured from the U.S. government by compliance with laws relating to such lands.

Percent grade (of uranium). The total amount of processed uranium that can be extracted from a given amount of ore, typically given as percent U_3O_8.

Perennial. Lasting or active throughout the entire year.

Perennial stream. A stream or reach of a stream that flows throughout the year, fed by springs or groundwater.

Permeability. The measure of the ease with which a fluid can diffuse through a particular porous material.

Petroglyph. Literally, a rock carving; petroglyphs usually exclude writing and are of prehistoric or protohistoric age.

Physiographic. Describing the shape and features of the land's surface.

Physiographic province. An area characterized by distinctive topography, geological structure, climate, drainage patterns, and other features and phenomena of nature.

Plan of operations. See *Mine plan of operations.*

Point source. Any discernible, confined, and discrete conveyance, including any pipe, ditch, channel, tunnel, or conduit, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

Preferred Alternative. The alternative recommended for implementation by the project proponent based on the evaluation completed in the NEPA process.

Prevention of significant deterioration. A regulatory program based not on the absolute levels of air pollution allowable in the atmosphere but on the amount by which a legally defined baseline condition will be allowed to deteriorate in a given area. Under this program, geographic areas are divided into three classes, each allowing different increases in nitrogen dioxide, particulate matter, and sulfur dioxide concentrations. Prevention of significant deterioration above legally established levels includes the following, used to classify a region:

- Class I—minimal additional deterioration in air quality (certain national parks and wilderness areas).
- Class II—moderate additional deterioration in air quality (most lands).
- Class III—greater deterioration for planned maximum growth (industrial areas).

Primacy state. A state of the United States that is authorized by the U.S. Environmental Protection Agency to administer portions of the Clean Water Act; Arizona is a primacy state.

Project alternatives. Alternatives to the proposed project developed through the National Environmental Policy Act process.

Quaternary. The geological period following the Tertiary in the Cenozoic Era, beginning about 1.8 million years ago, composed of the Pleistocene and Holocene epochs, characterized by the evolution of hominids into modern humans.

Rangeland. Land used for grazing by livestock and big-game animals on which vegetation is dominated by grasses, grass-like plants, forbs, or shrubs.

Reasonably foreseeable development scenario. Predicts the level and type of reasonably foreseeable future locatable mineral exploration and development that could occur in the proposed withdrawal area.

Reclamation. The process of contouring, stabilizing, and/or vegetating to convert disturbed land to its former use or other productive uses.

Record of Decision. A public document that explains which alternative will be selected for the area of concern. In addition to the decision, the Record of Decision states the alternatives considered, environmentally preferable alternative or alternatives, factors considered in the agency's decision, and mitigation measures that will be implemented and identifies any applicable enforcement and monitoring programs.

Right-of-way. Strip of land acquired by legal means over which, for example, power lines and access roads would pass.

Riparian. Typically refers to vegetation that requires the continual presence of water and therefore tends to grow near streams, springs, or lakes.

Riparian area. Land areas that are directly influenced by water. They usually have visible vegetative or physical characteristics that show water influence. Stream sides, lake borders, and marshes are typical riparian areas.

Road density. The number of miles of road per square mile.

Runoff. Precipitation that is not retained on the site where it falls and that is not absorbed by the soil or lost to the atmosphere.

Salable minerals. Common-variety mineral materials, such as sand, gravel, cinders, and building stone, that are sold on a permit basis. Also referred to as mineral materials.

Scope. The range of actions, alternatives, and impacts to be considered in an Environmental Impact Statement.

Scoping. A term used to identify the process for determining the range of issues related to a Proposed Action and for identifying significant issues to be addressed in an Environmental Impact Statement. Scoping may involve public meetings, field interviews with representatives of agencies and interest groups, discussions with resource specialists and managers, and comments received by the lead federal agency in response to news releases, direct mailings, articles, and Internet postings about the Proposed Action.

Sediment. Soil or mineral particles transported by moving water, wind, gravity, or glaciers and deposited in streams or other bodies of water or on land.

Sedimentary rock. Rock formed from consolidation of loose sediment that has accumulated in layers and become cemented.

Seepage. The discharge of water from an unlined facility or mine.

Sensitive species. Species whose populations are small and widely dispersed or restricted to a few localities; species that are listed or candidates for listing by the state or federal government.

Short-term impacts. Short-term impacts are temporary and either direct or indirect. Short-term impacts usually occur during the construction phase of the activity.

Significance. Significance requires consideration of the context and intensity of the impact under consideration. Significance can vary in relation to the context of the Proposed Action. Both short- and long-term impacts may be relevant. Impacts may also be evaluated in terms of their intensity or severity.

Soil productivity. The capacity of a soil to produce a plant or sequence of plants under a system of management.

Soil texture. The relative proportions of sand, silt, and clay particles in a mass of soil. Basic textural classes, in order of increasing proportion of fine particles, are as follows: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, silty clay loam, clay loam, sandy clay, and clay.

Species. A group of individuals of common ancestry that closely resemble each other structurally and physiologically and in nature interbreed, producing fertile offspring.

Stand. A community of trees possessing sufficient uniformity of composition, constitution, age, spatial arrangement, or condition as to be distinguishable from adjacent communities, forming a silvicultural management entity.

Stratigraphy. The arrangement of rock strata, especially as relates to geographic position and chronological order of sequence.

Subsidence. The gradual settling or sinking of an area, usually as a result of the withdrawal of large amounts of groundwater.

Subsurface. A zone below the surface of the earth whose geological features are principally layers of rock that have been tilted or faulted and are interpreted on the basis of drill hole records and geophysical (seismic or rock vibration) evidence. Generally, it is all rock and solid materials lying beneath the earth's surface.

Tertiary. The older of the two geological periods, from 62 million to 2 million years ago, that form the Cenozoic Era; also, the system of rock strata deposited during that period.

Threatened and endangered species. Animal or plant species that are listed under the Federal Endangered Species Act of 1973, as amended.

Ton. A short ton (2,000 pounds).

Tonne. A metric tonne (2,204.6 pounds).

Total suspended particulates. All particulate matter less than 70 microns in effective diameter that is suspended in a water body.

Traditional Cultural Property. A location that is valued by a group, such as an ethnic group, because it is a place of cultural patrimony and an important place in the traditional cultural landscape.

Uranium. A metallic element naturally occurring in the earth's surface. Uranium is present in water, soil, and rock and is always found combined with other elements to form a variety of common minerals.

Uranium endowment. The uranium occurring in rock that exceeds 0.01% U_3O_8 (see *Percent grade*).

Viewshed. The visible portion of the specific landscape seen from a specific viewpoint, normally limited to landform, vegetation, distance, and existing cultural modifications.

Visual quality objectives. The degree of acceptable alteration of the characteristic landscape.

Visual resources. The visible physical features of a landscape (topography, water, vegetation, animals, structures, and other features) that constitute the scenery of an area.

Waste rock. Non-ore rock that is extracted to gain access to ore. It contains no ore metals or contains ore metals at levels that are below the economic cutoff value and that must be removed to recover the ore.

Water table. The elevation of water at saturation in subsurface materials, whether permeable, porous, or not. Typically, it is the level of the groundwater in a given location.

Waters of the United States. A jurisdictional term typically associated with Section 404 of the Clean Water Act that refers to water bodies such as lakes, rivers, streams (including intermittent and ephemeral streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds with defined bed and bank, the use, degradation, or destruction of which could affect interstate or foreign commerce.

Watershed. The entire land area that contributes water to a drainage or stream.

Wetlands. An area that is regularly saturated by surface water or groundwater and subsequently supports vegetation that is adopted for life in saturated soil conditions. To qualify as a U.S. Army Corps of Engineers jurisdictional wetland, it must have hydric soil, be saturated to the surface sometime during the growing season, and contain wetland plant species.

Wildfire. Any fire on wildlands that was not intentionally set for management purposes and confined to a predetermined area.

Wind rose. Any one of a class of diagrams designed to illustrate the distribution of wind direction experienced at a given location over a given period. Wind roses may also give information concerning stability, distribution of wind speed, and other meteorological parameters.

Withdrawal. As defined in FLPMA, the term "withdrawal" means withholding an area of Federal land from settlement, sale, location, or entry, under some or all of the general land laws, for the purpose of limiting activities under those laws in order to maintain other public values in the area of reserving the area for a particular public purpose or program; or transferring jurisdiction over an area of Federal land, other than 'property' governed by the Federal Property and Administrative Services Act, as amended (40 U.S.C. 472) from one department, bureau or agency to another department, bureau or agency.

Chapter 8

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Appendix A

FEDERAL REGISTER NOTICE

Dated: July 13, 2009.

Dominica Van Koten,

Chief Cadastral Surveyor.

[FR Doc. E9–17292 Filed 7–20–09; 8:45 am]

BILLING CODE 4310–GJ–P

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

Notice of Proposed Withdrawal and Opportunity for Public Meeting; Arizona

AGENCY: Bureau of Land Management, Interior.

ACTION: Notice.

SUMMARY: The Secretary of the Interior proposes to withdraw approximately 633,547 acres of public lands and 360,002 acres of National Forest System lands for up to 20 years from location and entry under the Mining Law of 1872, 30 U.S.C. 22 *et seq.,* on behalf of the Bureau of Land Management and the United States Forest Service. The purpose of the withdrawal, if determined to be appropriate, would be to protect the Grand Canyon watershed from adverse effects of locatable hardrock mineral exploration and mining. This notice segregates the lands from location and entry under the 1872 Mining Law for up to 2 years to allow time for various studies and analyses, including appropriate National Environmental Policy Act analysis. These actions will support a final decision on whether or not to proceed with a withdrawal. The lands will remain open to the mineral leasing, geothermal leasing, mineral materials, and public land laws.

DATES: Comments and requests for a public meeting must be received by October 19, 2009.

ADDRESSES: Comments and meeting requests should be sent to the District Manager, Bureau of Land Management, Arizona Strip District Office, 345 East Riverside Drive, St. George, Utah 84790–9000, or Forest Supervisor, Forest Service, Kaibab National Forest, 800 South Sixth St., Williams, Arizona 86046.

FOR FURTHER INFORMATION CONTACT: Scott Florence, District Manager, BLM Arizona Strip District, 435–688–3200, or Michael Williams, Forest Supervisor, Kaibab National Forest, 928–635–8200.

SUPPLEMENTARY INFORMATION: The applicant is the Bureau of Land Management at the address above and its petition/application requests the Secretary of the Interior to withdraw, subject to valid existing rights, the following public lands and National Forest System lands from location and entry under the 1872 Mining Law, but not the mineral leasing, geothermal leasing, mineral materials laws, or public land laws: All the Federal lands identified in the townships below, and all non-Federal lands within the exterior boundaries described below that are subsequently acquired by the Federal government, to the boundary of the Grand Canyon National Game Preserve, including the overlap of the withdrawal for the Kanab Creek Wilderness, as depicted on the map entitled ''Petition/ Application for Withdrawal'' available from the BLM Arizona Strip District office and the FS Kaibab National Forest office at the addresses listed above.

Public Lands

Gila and Salt River Meridian, Arizona

Tps. 40 and 41 N., R. 1E.,
Tps. 38 and 40 N., R. 3 E., to the boundary of the Vermilion Cliffs National Monument,
Tps. 36 to 38 N., Rs. 4 and 5 E., to the boundary of the Vermilion Cliffs National Monument,
Tps. 37 to 39 N., R. 6 E., to the boundary of the Vermilion Cliffs National Monument,
T. 39 N., R. 7 E., to the boundary of the Vermilion Cliffs National Monument,
Tps. 38 to 41 N., R. 1 W.,
Tps. 38 to 40 N., R. 2 W.,
Tps. 36 to 40 N., R. 3 W.,
Tps. 35 to 40 N., Rs. 4 and 5 W.,
Tps. 35 to 39 N., Rs. 6 and 7 W.,

The areas described contain approximately 633,547 acres of public lands in Coconino and Mohave Counties.

National Forest System Lands

Kaibab National Forest

Gila and Salt River Meridian, Arizona.

North Kaibab Ranger District

Tps. 37 to 40 N., R. 3 E., to the boundary of the Vermilion Cliffs National Monument,
Tps. 36 and 37 N., R. 4 E.,
T. 36 N., R. 5 E.,
T. 38 N., R. 3 W.,
Tps. 36 and 37 N., Rs. 3 and 4 W.,

Tusayan Ranger District

Tps. 28 to 31 N., R. 1 E.,
Tps. 28 to 30 N., R 2 E.,
Tps. 27 to 30 N., Rs. 3 to 6 E.,
Tps. 31 and 32 N., R 1 W.,

The areas described contain approximately 360,002 acres of National Forest System lands in Coconino and Mohave Counties.

The total areas described aggregate approximately 993,549 acres of both public and National Forest System lands in Coconino and Mohave Counties located adjacent to the Grand Canyon National Park in Arizona. The total non-Federal lands within the area aggregate approximately 85,673 acres in Coconino and Mohave Counties.

The Secretary of the Interior has approved the Bureau of Land Management's petition for approval to file its withdrawal application. The Secretary's approval of the petition constitutes his proposal to withdraw the subject lands. The Forest Service has consented to proposing the withdrawal of lands under its administrative jurisdiction.

The purpose of the withdrawal, if determined to be appropriate, would be to protect the Grand Canyon watershed from adverse effects of locatable hardrock mineral exploration and mining for up to a 20-year period, which is the maximum allowable for a withdrawal aggregating more than 5,000 acres.

The use of a right-of-way, interagency, or cooperative agreement, or surface management by the Bureau of Land Management under 43 CFR 3715 and 3809 regulations and by the Forest Service under 36 CFR 228 would not adequately constrain nondiscretionary uses which could result in permanent loss of significant values and irreplaceable resources at the site.

There are no suitable alternative sites for the withdrawal.

No water rights would be needed to fulfill the purpose of the requested withdrawal.

Records relating to the application may be examined by contacting the BLM District Manager at the above address or by calling 435–688–3200 or the Forest Supervisor, Kaibab National Forest, 800 South Sixth Street, Williams, AZ 86046 or by calling 928–635–8200.

For a period of 90 days from the date of publication of this notice, all persons who wish to submit comments, suggestions, or objections in connection with the proposed withdrawal may present their views in writing to the BLM District Manager at the address noted above.

Comments including names and street addresses of respondents will be available for public review at the BLM Arizona Strip District Office at the address noted above, during regular business hours 8 a.m. to 4:30 p.m., Monday through Friday, except holidays. Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. Individual respondents may request confidentiality. If you wish to withhold your name or address from public review or from disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your comments. Such requests will be honored to the extent allowed by law. All submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public inspection in their entirety.

Notice is hereby given that one or more public meetings will be held in connection with the proposed withdrawal. All interested persons who desire a public meeting for the purpose of being heard on the proposed withdrawal must submit a written request to the BLM District Manager no later than October 19, 2009. A notice of the time and place of any public meetings will be published in the **Federal Register** and a local newspaper at least 30 days before the scheduled date of the meeting.

This application/proposal will be processed in accordance with the regulations set forth in 43 CFR part 2300.

For a period of 2 years from the date of publication of this notice in the **Federal Register**, the lands described in this notice will be segregated from location and entry under the 1872 Mining Law, unless the application/proposal is denied or canceled or the withdrawal is approved prior to that date. Licenses, permits, cooperative agreements, or other discretionary land use authorizations may be allowed with the approval of an authorized officer of the Bureau of Land Management or Forest Service during the segregative period.

Authority: 43 CFR 2310.3–1.

Dated: July 16, 2009.

Mike Pool,

Acting Director, Bureau of Land Management.

[FR Doc. E9–17293 Filed 7–20–09; 8:45 am]

BILLING CODE 4310–32–P

DEPARTMENT OF JUSTICE

Notice of Lodging of Consent Decree Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (''CERCLA'')

Notice is hereby given that on July 15, 2009, a proposed Consent Decree in *United States* v. *Landia Chemical Company et al.,* Civil Action No. 8:09–cv–01325–VMC–TBM, was lodged with the United States District Court for the Middle District of Florida.

The Consent Decree resolves claims brought by the United States, on behalf of the United States Environmental Protection Agency (''EPA''), against seven parties (''Settling Defendants'') under Sections 106 and 107 of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9606 and 9607. In its Complaint, filed concurrently with the Consent Decree, the United States sought injunctive relief in order to address the release or threatened release of hazardous substances at the Landia Chemical Company Site in Lakeland, Polk County, Florida, along with the recovery of costs the United States incurred for response activities undertaken at the Site.

Under the Consent Decree, the Settling Defendants—Landia Chemical Company, Inc.; Agrico Chemical Company; BASF Sparks LLC; PCS Joint Venture, Ltd.; Sylvite Terminal & Distribution LLC; Billy G. Mitchell; and Walter G. Grahn—will implement the remedy selected by EPA for the Site, including a final action to remediate soil contamination and an interim action to address groundwater contamination. The Consent Decree also requires the Settling Defendants to pay any future response costs above $796,454.46 incurred by the United States.

The Department of Justice will receive for a period of thirty (30) days from the date of this publication comments relating to the Consent Decree. Comments should be addressed to the Assistant Attorney General, Environment and Natural Resources Division, and either e-mailed to *pubcomment-ees.enrd@usdoj.gov* or mailed to P.O. Box 7611, U.S. Department of Justice, Washington, DC 20044–7611, and should refer to *United States* v. *Landia Chemical Company, Inc. et al.,* D.J. Ref. No. 90–11–3–09147.

The Consent Decree may be examined at the Office of the United States Attorney, Middle District of Florida, 400 N. Tampa Street, Suite 3200, Tampa, FL 33602, and at U.S. EPA Region 4, 61 Forsyth Street, SW., Atlanta, Georgia, 30303. During the public comment period, the Consent Decree may also be examined on the following Department of Justice Web site: *http://www.usdoj.gov/enrd/Consent_Decrees.html.* A copy of the Consent Decree may also be obtained by mail from the Consent Decree Library, P.O. Box 7611, U.S. Department of Justice, Washington, DC 20044–7611 or by faxing or e-mailing a request to Tonia Fleetwood (*tonia.fleetwood@usdoj.gov*), fax no. (202) 514–0097, phone confirmation number (202) 514–1547. In requesting a copy from the Consent Decree Library, please enclose a check in the amount of $59.75 (25 cents per page reproduction cost) payable to the U.S. Treasury or, if by email or fax, forward a check in that amount to the Consent Decree Library at the stated address.

Maureen Katz,

Assistant Section Chief, Environmental Enforcement Section, Environment and Natural Resources Division.

[FR Doc. E9–17226 Filed 7–20–09; 8:45 am]

BILLING CODE 4410–15–P

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

[Notice (09–067)]

Notice of Information Collection Under OMB Review

AGENCY: National Aeronautics and Space Administration (NASA).

ACTION: Notice of information collection under OMB review.

SUMMARY: The National Aeronautics and Space Administration, as part of its continuing effort to reduce paperwork and respondent burden, invites the general public and other Federal agencies to take this opportunity to comment on proposed and/or continuing information collections, as required by the Paperwork Reduction Act of 1995 (Pub. L. 104–13, 44 U.S.C. 3506(c)(2)(A)).

DATES: All comments should be submitted within 30 calendar days from the date of this publication.

ADDRESSES: All comments should be addressed to Jasmeet Seehra, Desk Officer for NASA, Office of Information and Regulatory Affairs, Room 10236, New Executive Office Building, Washington, DC 20503.

FOR FURTHER INFORMATION CONTACT: Requests for additional information or copies of the information collection instrument(s) and instructions should be directed to Dr. Walter Kit, NASA Clearance Officer, NASA Headquarters, 300 E Street, SW., JF0000, Washington, DC 20546, (202) 358–1350, *Walter.Kit-1@nasa.gov.*

SUPPLEMENTARY INFORMATION:

I. Abstract

NASA will collect information to determine which applicants meet required selection criteria and to what extent. Ten secondary educators from institutions nation-wide will be selected to participate in the Airborne Research Experience for Educators (AREE) project based on their experience and educational background.

Appendix B

LOCATABLE MINERAL RESOURCES—REASONABLY FORESEEABLE DEVELOPMENT SCENARIOS

B.1 INTRODUCTION

B.1.1 Purpose

The purpose of the reasonably foreseeable development (RFD) scenarios presented in this appendix is to provide a prediction of the level and type of reasonably foreseeable future locatable mineral exploration and development that could occur in the proposed withdrawal area. A predicted level of activity is first prepared for the No Action Alternative (Alternative A, Section B.8.1). The resulting development scenario is then adjusted based on the constraints of each alternative (Sections B.8.2 through B.8.4) and provides a uniform set of assumptions about reasonably foreseeable future locatable mineral exploration and development. These activity assumptions, in conjunction with existing conditions, serve as the basis for the impact assessment of each alternative as presented in Chapter 4 of the environmental impact statement (EIS). The RFD is by its nature speculative in attempting to predict future types and levels of locatable mineral exploration and development. The important feature of the RFD is not its numeric accuracy when it comes to the number of drill holes, ore tonnage, mines, or acres, but rather that it uses consistent assumptions to portray the relative levels of reasonably foreseeable future actions across the alternatives.

The RFD analysis is organized first with a discussion of provisions contained in the General Mining Law of 1872 (Mining Law), the legal framework under which mineral exploration and development occur in the study area (Section B.2). This is followed by an outline of the steps involved in developing a mineral deposit, beginning with the existing regulatory framework (Sections B.3 and B.4). Current activity levels are profiled (Section B.5), followed by an assessment of development potential (Section B.6) and future trends and assumptions for commodity markets, technology, and legal frameworks (Section B.7). Finally, predictions regarding the anticipated mineral exploration and development are presented, along with likely variation by EIS alternative (Section B.8). A summary of the RFD analysis for each alternative is included in Section B.9, along with a summary of all assumptions used to develop this analysis.

B.1.2 Scope

An RFD scenario is a prediction based on the known or inferred locatable mineral resource capabilities of the lands in the proposed withdrawal area using a set of assumed future economic, regulatory, and legal conditions. As such, it is subject to change as additional mineral resource data become available or as the economic, regulatory, and/or legal circumstances change. While historic mine development can give some idea of future development, there are other factors that affect the pace of future development. The pace of future development may not mimic that of the past because of changing prices or markets (see the subsection under B.8.1 on uncertainty factors), changing technologies that may improve exploration success, or the possibility of being able to improve mining success by building on information collected through exploration in years past. These factors contribute to a different assumed future development pattern than was experienced in the past.

The scope of this RFD analysis incorporates only locatable minerals; salable and leasable resources are not considered because they would not be subject to the proposed withdrawal. The mineral development scenarios presented within this analysis address only locatable minerals. The mineral commodity dominating activity is uranium, specifically uranium that occurs within breccia pipe deposits. Other precious metals and rare earth metals could be recovered from breccia pipe deposits concurrent with uranium mining, including gold, silver, copper, and vanadium. However, recovery of these additional metals has historically been secondary to uranium recovery, and the economic value from recovery of these metals is assumed to not be sufficient to drive mine development. Therefore, uranium resources are used in this analysis as the major indicator of mining activity.

The types of land included in the RFD scenarios are focused on federal surface and federal minerals administered by the Bureau of Land Management (BLM) and U.S. Forest Service (Forest Service), as well as split-estate lands. Activities on private or state lands are discussed where applicable.

B.1.3 Study Area

A complete description of the proposed withdrawal area boundaries, geology, and mining history can be found in Chapter 3 of the EIS. The proposed withdrawal area consists of three parcels: the North Parcel, which consists of 549,995 acres on the Kanab Plateau; the East Parcel, which consists of 134,454 acres in the House Rock Valley; and the South Parcel, which consists of 322,096 acres of the Kaibab National Forest south of the Grand Canyon.

Uranium mineralization was first discovered in the breccia pipes of northern Arizona in 1947. The uranium occurred in association with copper mineralization at the Orphan mine 2 miles west of the visitor's center on the South Rim of the Grand Canyon (not within the proposed withdrawal area). The first uranium ore was shipped by the Golden Crown Mining Company in 1956 to a buying station in Tuba City, Arizona. Before closing in 1969, the Orphan operation produced a reported total of 2,200 tons processed uranium (U_3O_8).

Since the discovery of uranium in the Orphan Mine, extensive fieldwork has been conducted by government and private concerns to define the spatial extent of the breccia pipes in northern Arizona. This work has included ground and airborne geophysical surveys, mapping of rock exposures in the deep canyons of the area, mapping on aerial photos, shallow and deep drilling, electric logging in drill holes, laboratory analysis of drill core, and 2- and 3-dimensional computer modeling. In addition, subsurface data have been obtained from observations and measurements taken in the historic underground mines.

The recognition of a relationship between uranium and copper mineralization sparked an investigation of several small copper deposits in the region. Uranium was identified in the Hack Canyon copper mine on the Arizona Strip in the 1950s but it was not until 1974, when Western Nuclear discovered uranium ore bodies in the Hack 1 and Hack 2 breccia pipes, that industry began to focus attention on the emerging district. Energy Fuels Nuclear Inc. (Energy Fuels Nuclear) acquired the Hack Canyon ore bodies in 1980 and initiated an intense campaign of land acquisition and exploration that uncovered seven ore bodies over the next 10 years. With the entrance of Pathfinder Mines and Union Pacific Resources, at least three additional mineralized breccia pipes were added to the discoveries in northern Arizona.

From the 1950s through the 1990s, 10 breccia pipes were developed or mined for uranium ore within the proposed withdrawal area. The history of development for these mines is shown in Table B-1. Until the 1980s, the only mine producing uranium within the proposed withdrawal area was the original Hack Canyon Mine, which had ceased production in 1964. Additional pipes were discovered in Hack Canyon in the 1970s, and production from these breccia pipes began in 1981. Exploration uncovered six other breccia pipes with minable uranium ore during the early and mid-1980s, and production from these mines began with the Pigeon mine in 1984. By the end of 1990, all uranium production from the proposed withdrawal area had ceased. Six mines were considered mined out and were closed or reclaimed (the four

Hack Complex pipes, Pigeon, and Hermit). Four other mines were placed under interim management; two of these had been partially mined (Kanab North and Pinenut), while the other two had never been put into production (Canyon and Arizona 1). Arizona 1 remained under interim management until resuming production in late 2009.

Table B-1. Historical Mine Development within the Proposed Withdrawal Area

	Discovered	Development	Production	Interim Management	Reclamation	Reactivated
Pigeon	1980	1982–1984	1984–1989	N/A	1989	N/A
Kanab North	1981	1984–1987	1988–1990	1992	N/A	
Hack Complex (Original pipe)	1900s	N/A	For uranium: 1950–1954, 1964	N/A	1987–1988	N/A
Hack Complex (Hack 1)	Mid-1970s	unknown	1981–1987	N/A	1987–1988	N/A
Hack Complex (Hack 2)	Late 1970s	unknown	1981–1987	N/A	1987–1988	N/A
Hack Complex (Hack 3)	Late 1970s	unknown	1982–1987	N/A	1987–1988	N/A
Hermit	1986	1987–1988	1989	N/A	1990	N/A
Pinenut	1982	1984–1986	1987–1989	1989	N/A	N/A
Canyon	1982	1984–1986	N/A	early 1990s	N/A	N/A
Arizona 1	Unknown	unknown	N/A	early 1990s	N/A	2009

During the 1980s, it appears to have taken from three to seven years following discovery of a breccia pipe to begin production of uranium. From 1981 through 1989, between three and five mines appear to have been active at any one time, with peak production appearing to be in 1987, as shown in Table B-2.

Table B-2. Historical Number of Mines Concurrently in Production in the Proposed Withdrawal Area

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Pigeon				×	×	×	×	×	×	
Kanab North								×	×	×
Hack 1	×	×	×	×	×	×	×			
Hack 2	×	×	×	×	×	×	×			
Hack 3		×	×	×	×	×	×			
Hermit									×	
Pinenut							×	×	×	
Number of Mines in Production	2	3	3	4	4	4	5	3	4	1
Approximate Price of Uranium ($/lb)*	$23	$20	$21	$18	$17	$18	$18	$15	$10	$10

* Available at: <http://www.mongabay.com/commodities/price-charts/price-of-uranium.html>.

While other types of uranium deposits occur within northern Arizona and southern Utah, no other geological type of uranium deposit is known to be located within the proposed withdrawal area. Therefore, the RFD scenarios focus on the exploration and mining of breccia pipe uranium deposits.

B.2 MINING LAW OF 1872

The General Mining Law of 1872 [30 United States Code (USC) 22–54] authorizes citizens to stake or "locate" mining claims on federal lands. Only minerals considered "locatable" are subject to appropriation under the Mining Law. Locatable minerals include metallic minerals (gold, silver, lead, uranium, etc.), nonmetallic minerals (fluorspar, asbestos, mica, gemstones, etc.), and certain "uncommon variety" minerals.

There are two types of mining claims: lode and placer. Lode claims are generally located on indurated bedrock, whereas placer claims are usually located on loosely consolidated materials, such as mineral-bearing sands and gravels. Mining claims associated with uranium-bearing breccia pipe deposits are lode claims.

Mining claimants establish valid mining claims by making a "discovery" of a valuable mineral deposit and complying with all other applicable statutory and regulatory requirements, such as posting a notice of location at the discovery point and marking the claim on the ground to ensure that the claim boundaries are readily identifiable. A valid mining claim gives the claimant the right to possess and develop the mineral deposit. This right has to be exercised consistent with all applicable state and federal environmental protection requirements.

Only lands that are open to mineral entry are available for the location of new mining claims. This means that no new mining claims may be located after lands are segregated or withdrawn from location and entry under the Mining Law. A segregation or withdrawal is made "subject to valid existing rights." Mining claimants may continue to hold and develop valid mining claims that predate the segregation or withdrawal, subject to all applicable statutes and regulations.

B.3 REGULATORY FRAMEWORK

The BLM and the Forest Service have promulgated surface management regulations governing mining operations conducted under the Mining Law, including exploration and development related to the breccia pipe uranium deposits in the proposed withdrawal area. Operators on BLM lands must comply with the regulations at 43 Code of Federal Regulations (CFR) 3809, as well as the use and occupancy regulations at 43 CFR 3715. Operators on National Forest System lands must comply with the regulations at 36 CFR 228A. In addition, operators must comply with all other federal, state, and local laws and regulations.

B.3.1 Federal Surface Management Regulations

BLM classifies operations on public lands in one of three categories:

- casual use, involving non-mechanized activity for which an operator need not notify the BLM;
- Notice-level exploration operations, for which an operator must submit a Notice; and
- plan-level operations, for which an operator must submit a plan of operations and obtain BLM's approval before undertaking any activity.

Exploration activities typically can occur under a Notice, provided that surface disturbance totals less than 5 acres, activities involve removal of less than 1,000 tons of presumed ore, and activities do not fall within certain special management areas, including Areas of Critical Environmental Concern, Wilderness Areas, areas closed to off-road use, and habitat for proposed or listed threatened and endangered species. The BLM does not approve a Notice, although the operator is still required to comply with the performance standards and the bonding requirements described in the following section.

Mining and mine development activities, regardless of size, require that a plan of operations be submitted to the BLM and approved before any activity can be undertaken. Plans of operation provide detailed information on the operator, a description of the operations, a reclamation plan, a monitoring plan, and an interim management plan in the event that operations are halted temporarily.

The Forest Service has a similar classification; however, the distinction between a Notice of Intent and a plan of operations is at the discretion of the District Ranger. Under Forest Service regulations a Notice of Intent is submitted to the District Ranger, who then determines whether the proposed operations would cause significant disturbance of surface resources. The Forest Service then notifies the operator whether a plan of operations is required before the proposed activity can be undertaken.

The Forest Service and BLM permitting processes do not negate or supersede other state or federal permitting processes. Applicants must comply with all other federal and state laws and regulations prior to development of any mine. These additional permits are described in detail later in this section. In addition, the federal permitting agencies themselves are required to comply with the National Environmental Policy Act (NEPA), and the required environmental analysis is part of the overall BLM or Forest Service permitting process. Both agencies also require validity exams before approving plans of operation on withdrawn lands.

Performance Standards

The BLM performance standards are divided into two types—general and specific performance standards. These performance standards apply to casual use activities, Notices, and plans of operation. The basic performance standard is the prevention of unnecessary or undue degradation. Operators must prevent unnecessary or undue degradation while conducting operations on public lands by operating in accordance with the requirements in 43 CFR 3809.415(a–c). As defined in 43 CFR 3809.5, unnecessary or undue degradation means conditions, activities, or practices that

- fail to comply with one or more of the performance standards in 43 CFR 3809.420, the terms and conditions of an approved plan of operations, operations described in a complete Notice, and other federal and state laws related to environmental protection and protection of cultural resources;
- are not "reasonably incident" to prospecting, mining, or processing operations as defined in 43 CFR 3715.0–5; or
- fail to attain a stated level of protection or reclamation required by specific laws in areas such as the California Desert Conservation Area, Wild and Scenic Rivers, BLM-administered portions of the National Wilderness System, and BLM-administered National Monuments and National Conservation Areas.

To prevent unnecessary or undue degradation, operators must comply with the performance standards in 43 CFR 3809.420; follow their accepted Notice or approved plan of operations; and comply with other federal and state laws related to environmental protection and protection of cultural resources.

The regulations [43 CFR 3809.420] establish procedures and standards to ensure that operators and mining claimants meet their responsibility to prevent unnecessary or undue degradation of the land and reclaim disturbed areas. The standards are generally outcome-based and do not contain specific design or operational requirements for operations. The general performance standards require that operators

- use appropriate technology and practices,
- undertake activities in a logical sequence,
- comply with the applicable BLM land use plan,
- take any mitigation measures as specified by BLM,

- conduct proper and appropriate reclamation activities, and
- comply with all pertinent state and federal laws.

The specific performance standards address issues related to

- the planning, construction, and use of access routes;
- disposal of mining wastes;
- reclamation;
- disposal of solid wastes;
- prevention of adverse impacts to fisheries, wildlife, and related habitat;
- prevention of disturbance, alteration, or destruction of cultural and paleontological resources;
- protection of survey monuments;
- fire prevention and suppression;
- the handling and treatment of acid-forming and toxic materials;
- the operation, design, and construction of leaching operations; and
- the maintenance and safety of structures and equipment.

In addition to meeting the performance standards, all activity conducted under a Notice or plan of operations must be reasonably incident to prospecting, mining, or processing operations and uses, as defined in 43 CFR 3715.0–5. This means that even the best-managed activity cannot be conducted under the 3809 regulations if the activity is not related to mineral exploration or development.

Forest Service regulations [36 CFR 228.8] require that all operations, where feasible, shall be conducted to minimize adverse environmental impacts on National Forest System surface resources, including the following:

- Air quality, including compliance with applicable federal and state air quality standards, including the requirements of the Clean Air Act.
- Water quality, including compliance with applicable federal and state water quality standards, including regulations issued pursuant to the federal Water Pollution Control Act.
- Solid wastes, including compliance with federal and state standards for the disposal and treatment of solid wastes. All garbage, refuse, or waste shall either be removed from National Forest System lands or disposed of or treated to minimize its impact on the environment and the forest surface resources. All tailings, dumpage, deleterious materials, or substances and other waste shall be deployed, arranged, disposed of, or treated to minimize adverse impacts on the environment and forest surface resources.
- Scenic values. The operator shall harmonize operations with scenic values through such measures as the design and location of operating facilities, including roads and other means of access, vegetative screening of operations, and construction of structures and improvements that blend in with the landscape.
- Fish and wildlife habitat. In addition to compliance with water quality and solid waste disposal standards required by this section, the operator shall take all practicable measures to maintain and protect fish and wildlife habitat that may be affected by the operations.
- Roads. Operator shall construct and maintain all roads to ensure adequate drainage and to minimize or, where possible, eliminate damage to soil, water, and other resource values.
- Reclamation. Upon exhaustion of the mineral deposit or at the earliest practicable time during operations, or within 1 year of the conclusion of operations, unless a longer time is allowed by the authorized officer, the operator shall, where practicable, reclaim the surface disturbed in

operations by taking measures that will prevent or control on- and off-site damage to the environment and forest surface resources.

Monitoring Plan

Among other things, the plan of operations pursuant to 43 CFR 3809 must include a monitoring plan. The purpose of monitoring is to

- demonstrate compliance with the plan of operations and other federal or state laws and regulations,
- provide early detection of potential problems, and
- supply information to assist in directing corrective actions.

For each resource to be monitored, the respective monitoring plan must describe the following:

- Type and location of monitoring devices,
- Sampling parameters and frequency,
- Analytical methods,
- Reporting procedures, and
- Procedures for responding to adverse monitoring results.

Reclamation Requirements

All operators on BLM administered lands are required to reclaim disturbed areas in accordance with the performance standards and their reclamation plans. Reclamation is defined in 43 CFR 3809.5 as follows:

> Reclamation means taking measures required by this subpart following disturbance of public lands caused by operations to meet applicable performance standards and achieve conditions required by BLM at the conclusion of operations. For a definition of “reclamation” applicable to operations conducted under the mining laws on Stock Raising Homestead Act lands, see part 3810, subpart 3814 of this title. Components of reclamation include, where applicable:
>
> 1) Isolation, control, or removal of acid-forming, toxic, or deleterious substances;
> 2) Regrading and reshaping to conform to adjacent landforms, facilitate revegetation, control drainage, and minimize erosion;
> 3) Rehabilitation of fish or wildlife habitat;
> 4) Placement of growth medium and establishment of self-sustaining revegetation;
> 5) Removal or stabilization of buildings, structures, or other support facilities;
> 6) Plugging of drill holes and closure of underground workings; and
> 7) Providing for post-mining monitoring, maintenance, or treatment.

On Forest Service lands, reclamation specifically requires the following [36 CFR 228.8]:

- Control of erosion and landslides;
- Control of water runoff;
- Isolation, removal, or control of toxic materials;
- Reshaping and revegetation of disturbed areas, where reasonably practicable; and
- Rehabilitation of fish and wildlife habitat.

Enforcement Provisions

At any time, the BLM may inspect operations on BLM lands. An inspection may include any physical aspect of the operation, including all structures, equipment, and workings located on public lands. An inspection may also include an examination of any pertinent files the operator may have related to the permitting of the operation and the storage of chemicals and supplies. Permits, approvals, and authorizations that are subject to verification include any documents issued or required by local, state, or federal authorities that are, or may be, required for lawful operation.

The BLM can issue various types of enforcement orders if an operator does not meet the requirements of the surface management regulations. The BLM may issue enforcement orders under either 43 CFR 3809 (noncompliance, or suspension) and/or 43CFR 3715 (immediate suspension, cessation, or notice of noncompliance).

On Forest Service lands, forest officers shall periodically inspect operations to determine whether the operator is complying with the regulations and an approved plan of operations [36 CFR 228.7]. If an operator fails to comply with the regulations or the approved plan of operations, the authorized officer shall serve a notice of noncompliance on the operator or his or her agent in person. Such notice shall describe the noncompliance and shall specify the action with which to comply and the time within which such action is to be completed, generally not to exceed 30 days.

B.3.2 Arizona State and Other Requirements

The following additional permits may be required for the mine site:

- Air Quality Permit from the Arizona Department of Environmental Quality (ADEQ);
- Aquifer Protection Permit (APP) from ADEQ;
- U.S. Army Corps of Engineers Section 404 Permit;
- Arizona Pollutant Discharge Elimination System (AZPDES) Permit from ADEQ;
- Compliance with National Emissions Standards for Hazardous Air Pollutants, in accordance with the U.S. Environmental Protection Agency (EPA) Region 9;
- Arizona Department of Water Resources (ADWR) well permit for production wells and most exploratory boreholes;
- Septic system permit from ADEQ; and
- Right-of-way or road maintenance permit from Mohave County or Coconino County.

ADEQ and ADWR regulate many activities associated with locatable minerals mining, including many activities associated with breccia pipe uranium mining operations. ADEQ has authority related to the potential discharge of contaminants to the vadose zone and aquifer, administered under the APP program. ADEQ also has authority over potential migration of contaminants by stormwater, administered under the AZPDES program. ADEQ, along with EPA, also is responsible for issuance of air quality permits related to mining activities that may discharge contaminants to the air.

ADWR has authority over the drilling and proper abandonment of most exploration holes, the drilling and construction of wells, and the use of groundwater; however, in the proposed withdrawal area there are no specific state requirements for obtaining groundwater rights, other than that the groundwater be put to beneficial use.

The state permitting process typically occurs on a separate yet concurrent track from approval of the plan of operations by the BLM or Forest Service. Both the BLM and Forest Service require that operators comply with all applicable federal, state, and local environmental protection requirements as a condition of maintaining the approved plan of operations.

A full list of the federal, state, and local permits typically required in order to develop a uranium mine is included in Attachment B-1.

B.3.3 Notice and Notice of Intent Review Process

Within 15 days of receiving a Notice, the BLM will advise the operator either that the Notice is complete or what information is required to complete the Notice. The BLM will advise the operator of any measures that must be incorporated into the Notice in order to prevent unnecessary or undue degradation. The operator may not begin operations until the required reclamation financial guarantee is received and accepted by the BLM.

Similarly, upon receipt the Forest Service will review a Notice of Intent and notify the operator whether a plan of operations is required to be filed or whether the activity can proceed under the Notice of Intent.

B.3.4 Plan of Operations Approval Process

The plan of operations approval process is summarized in Figure B-1. Upon receipt, the plan of operations is reviewed for completeness. A completeness review involves identifying any additional data that the operator must provide to allow assessment of impacts or any commitments that must be made by the operator to minimize adverse environmental impacts on National Forest System surface resources and eliminate unnecessary or undue degradation on BLM administered lands. Guidance and authorities used during the completeness review process include the Federal Land Policy Management Act, conformance with the appropriate resource management plan or forest plan, surface management regulations [43 CFR 3809 and 36 CFR 228A], and internal agency guidance documents. The deficiencies identified during a completeness review are enumerated to the proponent, who then revises the plan of operations as appropriate and resubmits it to the agency for another completeness review. The cycle of completeness review by the agency, with subsequent modification of the plan of operations by the applicant, continues until the application is declared "complete."

After a complete application is received, the environmental analysis is prepared, in accordance with NEPA requirements. Depending on the anticipated impacts of the proposal, this may be either an environmental assessment (EA) or an EIS.

BLM regulations provide a minimum 30-day public comment period on all plans of operation. This is usually done at the same time as public review of the environmental analysis.

After the environmental analysis is complete and the public comments have been considered, the agency issues its decision. Any operating or reclamation requirements determined necessary to prevent unnecessary or undue degradation and to comply with the performance standards are required as conditions of approval. A reclamation bond amount is calculated based on an engineering evaluation of what it would cost the agency to reclaim the operation as described in the approved reclamation plan. The bond must be posted before ground-disturbing activity can begin. Amendments to existing plans of operation are processed in a similar manner.

Figure B-1. Plan of operations approval process diagram.[1]

B.4 DEVELOPMENT OF A URANIUM MINE

The development of a breccia pipe uranium deposit from exploration to production can be divided into seven stages. Each stage requires the application of more discriminating (and more expensive) techniques over a successively smaller land area to identify, develop, and mine an economic mineral deposit. The full sequence of mine development involves the following stages:

- appraisal of a large region,
- reconnaissance of selected parts of the region,
- detailed surface investigation of a target area,
- three-dimensional physical sampling of the target area,
- development of the mine infrastructure,
- actual production, and
- mine reclamation.

[1] ROD = Record of Decision.

These can be grouped into five categories: reconnaissance, prospecting, exploration, mine development, and reclamation. A diagram showing the relationship between these various stages in the life of a uranium mine is shown in Figure B-2.

B.4.1 Reconnaissance

Reconnaissance-level activity is the first stage in exploring for a breccia pipe mineral deposit. This activity involves initial literature search of an area of interest using available references such as publications, reports, maps, aerial photographs, etc. The area of study can vary from hundreds to thousands of square miles.

Historically, the first breccia pipe deposits discovered by prospectors in northern Arizona were mainly identified as a result of their exposure by erosion along the walls of canyons incised into the Colorado Plateau and by the easily noticed presence of oxidized minerals within the breccia pipe. Later, geologists recognized that even where not exposed by erosion, breccia pipes often exhibit surface expression because of the collapse, deformation, or tilting of overlying sedimentary formations.

Reconnaissance activity that typically takes place in the present day includes large-scale mapping, regional geochemical and geophysical studies, and remote sensing with aerial photography or satellite imagery. The type of surface-disturbing activity typically associated with reconnaissance-level mineral inventory includes stream sediment, soil, or rock sampling. Minor off-road vehicle use may be involved, in accordance with local off-road travel restrictions. This activity would normally be considered casual use and not require a Notice, Notice of Intent, or plan of operations.

B.4.2 Prospecting

Through data uncovered during reconnaissance, stemming from anomalous geochemical or geophysical readings or unique geological structures or features, the occurrence of typical mineral-bearing formations, or a historical reference to past mineral occurrence, the prospecting area of interest is identified. Whereas with other locatable minerals, the area of prospecting could include large areas or even entire mountain ranges, for breccia pipes the prospecting area is typically limited to the suspected location of an individual breccia pipe, typically covering a few hundred acres.

Activities that take place in an effort to locate a breccia pipe include more detailed mapping, sampling, and geochemical and geophysical study programs. This is the time when most mining claims are located in order to establish primacy rights over any discovered breccia pipe uranium deposits against other potential operators.

A system of reconnaissance/prospecting specifically for breccia pipes is described in Wenrich (1992). The process typically starts with photogeological interpretation of color aerial photographs at a scale of 1:24,000. This step of the process focuses primarily on identifying circular features for further field investigation; however, aerial photographic interpretation is cautioned as not being adequate to identify the presence of a breccia pipe because of the large number of other geological features, such as karst-related depressions, that look similar. Based on the preliminary photographic interpretation, a low-level aerial survey is conducted to further refine the potential target list.

A final step in reconnaissance is field investigation of targets in order to specifically look for markers or indicators of a possible breccia pipe, including the presence of concentric, inward-dipping beds; bleached or limonite-stained rock; brecciated rock or mineralized rock; and circular or topographic anomalies. Types of surface-disturbing activity associated with prospecting involve more intense soil and rock chip sampling using mostly hand tools, frequent off-road vehicle use, and placement and maintenance of

Figure B-2. Mine life cycle diagram.

mining claim monuments. This activity is normally considered “casual use” and does not require BLM or Forest Service notification or approval unless it requires off-road travel in a closed area. Off-road travel may require a Notice, Notice of Intent, or plan of operations, depending on the specific circumstances.

Advances in remote-sensing technology have created new avenues for reconnaissance-level activities. In 2007, a survey was conducted by Quaterra Resources, Inc., using a technology known as Versatile Time Domain Electro-Magnetics (VTEM). VTEM is an aerial survey that identifies variations in the electrical conductance of geological formations; it is estimated that up to 70% of targets identified using this technique may be breccia pipes (personal communication, Spiering 2010c, 2010e).

B.4.3 Exploration

Upon location of a sufficiently anomalous mineral occurrence or favorable occurrence indicator, a mineral prospect is established and is subjected to more intense evaluation through exploration techniques. Activities that take place during exploration include those used during prospecting but at a more intense level in a smaller area. Typically for a breccia pipe deposit, activities include drilling of exploratory drill holes. For a prospective breccia pipe, exploratory drill holes (usually less than 600 feet deep) are drilled in order to identify the “throat” of the breccia pipe. Deeper boreholes (up to several thousand feet deep) are then advanced, and drill core samples obtained in order to determine the level and extent of mineralization at depth within the breccia pipe. Historically, drilling has been required to confirm the presence and mineralization of a breccia pipe; this may change in the future as new exploration and remote sensing techniques are perfected.

The disturbance associated with individual drill sites is typically limited to the area immediately surrounding the drill rig. Usually, access to drill sites can be accomplished by using existing roads and overland travel and does not involve road or drill pad construction or excavation. In some cases, construction of new temporary access roads is required, including blading and clearing of vegetation; these access roads are typically no greater than 12 feet wide. Overall, the surface disturbance associated with a typical exploration project amounts to less than 2 acres and can usually be accomplished under a BLM Notice or a Forest Service Notice of Intent, although in some cases, such as exploration in Areas of Critical Environmental Concern (BLM-administered lands), a plan of operations would be required instead. Upon completion of exploration activity, the drill holes are plugged and any surface disturbance is reclaimed. Reclamation for exploration sites is typically implemented within the same field season.

B.4.4 Mine Development

If exploration results show that an economically viable mineral deposit may be present, activity will intensify to obtain detailed knowledge regarding resources, possible mining methods, and mineral processing requirements. This involves applying all the previously used exploration tools in a more intense effort. Once enough information is acquired, a feasibility study would be conducted by the mine claimant to decide whether to proceed with mine development and which mining and ore processing methods would be used.

Once the decision to develop the property is made, the mine permitting process begins. Upon obtaining all necessary federal, state, and local permits, including the approval of a mining plan of operations, work begins on development of the mine infrastructure. All breccia pipes that have been historically mined within or near the proposed withdrawal area have used underground workings. The surface footprint of these mines is typically less than 25 acres. Further, all processing of uranium ore has historically occurred at a central processing facility, and this is expected to continue. No processing facilities would be located at the mine sites, and ore would be hauled off-site. Because of the decentralized nature of breccia pipe deposits, ore would be hauled by truck.

Waste rock may or may not be stockpiled at the surface during active mining activities. Waste rock is rock containing less than the minimum amount of uranium required for economical transport and processing. Auxiliary activities at the mine sites might include well construction, both for monitoring and as water for dust control, sanitation, and drilling blast holes for underground development. No water would be used for processing uranium ore on-site. Evaporation ponds would be constructed to contain any water produced by the mine, as well as to contain any rain water falling on the mine site from draining to the undisturbed land outside the mine's exterior boundaries. Off-site surface disturbance typically would be limited to the construction of haul roads. During the initial phases of construction, power would be provided by on-site generators and later by power lines.

As described in Section B.8.1.8, there are many uncertainty factors that could change the length of this phase of the life of a uranium mine, including permitting delays, a larger or smaller ore body, or an operator choosing to temporarily suspend production and operate under the interim management plan contained in the mine's approved plan of operations.

Interim Management

All approved mining plans of operation on BLM-administered lands contain an interim management plan that specifies the measures to be taken in the event of an extended period of non-operation before mining is completed. The actions to be taken under the interim management plan usually depend on the length of non-operation, which is typically categorized as short term (a few months to a year) or long term (more than a year). Actions to be taken are meant to stabilize the excavation and workings, isolate and contol toxic or deleterious materials, store or remove equipment, supplies, or structures, maintain the project area in a safe and clean condition, and monitor site conditions. Typical short-term and long-term interim management actions are described below.

TYPICAL SHORT-TERM INTERIM MANAGEMENT

A short shutdown of a few months to a year would require only limited action. In this case, a few employees may be kept at the mine site for repair and maintenance work, and a watchman may reside at the mine site. All inventory items that may deteriorate in a year's time, such as explosives, oil, gas and first-aid, supplies, would be used or removed from the mine site. Hardware, such as nuts, nails, and pipe fittings, would be secured in place. Hazardous materials at the mine site would be secured with locks in the shop building or warehouse. All equipment would be checked, and most of it would be stored in the shop building or in the mine working. Ventilation fans, electric lines, and transformers would be left in place. Steel gates on the mine shaft would be closed and locked.

All stockpiles above economic grade would be shipped to a mill for processing or maintained at the site. There would likely be some stockpiles of low-grade ore that would also be maintained at the mine site during short-term interim management. Measures would be taken to ensure that the development rock pile would be stabilized if necessary.

Monitoring would occur during the period of short-term interim management. The mine facilities area, buildings, mine shaft, vent holes, roads, evaporation ponds, and surrounding fencing would be inspected on a biannual basis. Maintenance of facilities and stabilization structures and controls would occur at the mine site following inspection activities and would be reported in annual reports. In addition, all permits would be maintained during closure and permit conditions would be adhered to.

TYPICAL LONG-TERM INTERIM MANAGEMENT

In the event of non-operation for more than a year, a different procedure would be followed. Nearly all mobile equipment and a portion of the fixed equipment would be removed from the mine site. Fans would be removed and the ventilation shaft capped with perforated steel plates welded in place to allow natural ventilation but prevent access to the workings. The buildings, headframe, and hoist would be left in place but secured and maintained in the same manner as for short-term interim management. All hazardous materials would be removed from the site and disposed of in accordance with state and federal regulations.

Like with short-term interim management, all stockpiles above economic grade would be shipped to a mill for processing or maintained at the site. There would likely be some stockpiles of low-grade ore that would also be maintained at the mine site during long-term interim management. Measures would be taken to ensure that the development rock pile would be stabilized if necessary.

Similar monitoring would occur during the period of long-term interim management. The mine facilities area, buildings, mine shaft, vent holes, roads, evaporation ponds, and surrounding fencing would be inspected on a biannual basis. Maintenance of facilities and stabilization structures and controls would occur at the mine site following inspection activities and would be reported in annual reports. In addition, all permits would be maintained during closure and permit conditions would be adhered to.

If operations are inactive for 5 consecutive years, the BLM will review the operations and determine whether the BLM should terminate the existing plan of operations and direct final reclamation and closure. If the BLM determines that operations are abandoned, they may initiate forfeiture under 43 CFR 3809.505. If the amount of the financial guarantee is inadequate to cover the costs of reclamation, BLM may complete the reclamation, and the operator and all other responsible persons are liable for the costs of such reclamation.

B.4.5 Mine Closure and Reclamation

Upon completion of, or concurrent with, mining, the property will be reclaimed. Permanent reclamation typically involves the backfilling of waste rock into the mine, sealing of the mine to re-establish subsurface hydraulic gradients and prevent mine drainage, dismantling and removal of infrastructure or equipment, revegetation of the mine site and haul roads, and long-term monitoring of reclamation success (Denison 2010). Once monitoring shows that the reclamation criteria established for a particular operation have been met, the reclamation financial guarantee may be reduced or released following a public comment period. Reclamation success typically takes several seasons to confirm after seeding or planting. Although time frames can be longer for mines under standby mode and operating under interm plans of operation, a typical mine site may be disturbed for 5 to 7 years. Under interim plans of operation, some interim seeding and reclamation could be required.

Several mines that operated in the 1980s have completed reclamation: the Hermit, Pigeon, and Hack Canyon mines. These mines were reclaimed in accordance with the reclamation critieria established in their respective plans of operation. Since then, recent U.S. Geological Survey (USGS) studies (USGS 2010) have identified levels of uranium in remnants of ore or waste rock on the reclaimed surface that exceed background levels.

B.5 CURRENT EXPLORATION AND MINING ACTIVITIES

Hundreds, if not thousands, of breccia pipes are likely to exist within the proposed withdrawal area; the majority of these are undiscovered. Historically, the presence of a breccia pipe can only be confirmed by actual drilling and usually only by drilling deep enough to identify the presence of breccia below the lower horizon of the Toroweap Formation. Within the proposed withdrawal area, to date, only about 45 breccia pipes have met this level of demonstration. These known breccia pipes fall into several categories, as summarized in Table B-3:

- Historic breccia pipes that have already been mined out,
- Historic breccia pipes with development and remaining uranium resources,
- Breccia pipes where no development has occurred but for which uranium resources have been estimated,
- Breccia pipes where some level of mineralization has been identified but for which uranium resources have not been documented, and
- Breccia pipes for which no sufficient data are available for determining the level of mineralization.

Many of the breccia pipes for which the presence of uranium resources have been confirmed were discovered and explored during the peak of northern Arizona uranium production in the 1980s, as described in Section B.1.3. With the exception of Arizona 1, these breccia pipes have remained undeveloped and unmined. A mining company's decision to develop or mine a breccia pipe is based on a number of factors, including uranium prices and the level of certainty about future conditions. As shown in Table B-2, part of the curtailment of mining by the end of the 1980s was due to a declining trend in commodity values. As prices have risen over the past decade, exploration activities have increased as well; however, with the exception of the resumption of mining in Arizona 1, no new breccia pipes have been developed or mined, partially as a result of the uncertainty of price and regulatory conditions.

Table B-3. Drill-confirmed Breccia Pipes within the Proposed Withdrawal Area

Breccia Pipe Name	Mined Out	Developed, with Resources Remaining	Mineralized and Unmined, with Resources Estimated	Mineralized and Unmined, with Resources Not Estimated	Undetermined
North Parcel					
A01				×	
A20				×	
Arizona 1		×			
Clearwater				×	
DB			×		
EZ-1			×		
EZ-2			×		
Findlay Tank NW			×		
Findlay Tank SE			×		
Gump				×	
Hack 1	×				
Hack 2	×				
Hack 3	×				
Hermit	×				
John				×	
June					×
Kanab North		×			
L. Robinson				×	
Lisa				×	
Lost Calf				×	
Ollie				×	
Peace				×	

Table B-3. Drill-Confirmed Breccia Pipes within the Proposed Withdrawal Area (Continued)

Breccia Pipe Name	Mined Out	Developed, with Resources Remaining	Mineralized and Unmined, with Resources Estimated	Mineralized and Unmined, with Resources Not Estimated	Undetermined
North Parcel, continued					
Pigeon	×				
Pinenut		×			
Rim			×		
Smuggler					×
Sunshine					×
UPR					×
Weap					×
What			×		
Subtotal	*5*	*3*	*7*	*10*	*5*
South Parcel					
Airport				×	
Auto				×	
Bank					×
Bank East					×
Black Box				×	
Butte NE				×	
Canyon		×			
New Year				×	
Otto 4				×	
Peterson Flat					×
Sayer					×
Shale				×	
Tap 2					×
Tap East				×	
Subtotal	*0*	*1*	*0*	*8*	*5*
East Parcel					
House Rock				×	
Subtotal	*0*	*0*	*0*	*1*	*0*
Total All Parcels	**5**	**4**	**8**	**19**	**10**

Source: personal communication, Spiering (2010a).

Located mining claims do not necessarily have any association with an actual breccia pipe, and even if they do correspond to an actual breccia pipe, only a fraction of the breccia pipes are mineralized (and even fewer to an extent that is economically viable for mining). Approximately 3,350 mining claims (as of August 2011) exist within the three proposed withdrawal parcels. Many times, mining claims are filed based on indirect evidence of locatable minerals; exploration, being more expensive, typically proceeds only for mining claims for which there is reasonable evidence that a breccia pipe exists.

It should be noted that the information presented in Table B-3 does not reflect any ongoing analysis of a specific mining claim's valid existing rights, nor does the use of these data for the purposes of this analysis presume or supersede any determination of valid existing rights through the normal administrative process, which occurs independent of the RFD analysis and the EIS. The data presented here should in no way be construed to infer valid existing rights for any specific claim. Rather, the purpose of presenting these data is to give an idea, based solely on the overall composition of mining claims and using professional judgment and knowledge, of breccia pipes that may represent targets for future mining proposals.

B.6 MINERAL POTENTIAL

Two factors are assessed in order to determine the mineral potential of an area: occurrence potential and development potential. Occurrence potential is the likelihood of the presence of locatable minerals, regardless of administrative, geographic, or economic constraints on development. Development potential is the ability to physically access and mine those deposits. In the proposed withdrawal area, there are few geographic constraints on the development of breccia pipes. Even where geographically unfavorable (i.e., canyons or steep slopes), the mine site can be located elsewhere and the ore bodies can be developed by lateral techniques.

Occurrence potential for uranium within the proposed withdrawal area has been detailed previously by Finch et al. (1990). The entire proposed withdrawal area is included in “Favorable Area A,” which is the area that has the highest level of development potential for uranium. Similarly, based on the criteria set forth in the BLM Manual 3031, the mineral potential classification for uranium is high occurrence with high level of certainty throughout the entire proposed withdrawal area. The geological environment, reported mineral occurrences and/or geochemical/geophysical anomaly, and known mines/deposits indicate a high potential for uranium resources. Available data provide abundant direct and indirect evidence to support the possible existence of mineral resources.

Based on historic discoveries and mine development, the North Parcel is considered to be the most prospective, followed by the South Parcel and then the East Parcel (BLM 2010). Thirty confirmed breccia pipes occur on the North Parcel; five of these have already been mined out, and three have been developed or are currently being mined. Fourteen confirmed breccia pipes occur on the South Parcel; none of these have been mined, and only one has been developed. The East Parcel contains only a single confirmed breccia pipe.

Development potential is also tied to the regulatory process. Development of a breccia pipe requires compliance with all federal, state, and local laws and regulation, which includes obtaining BLM or Forest Service approval on federal lands and agency completion of environmental analysis under NEPA. Some permitting, such as permitting for dredge and fill under Section 404 of the Clean Water Act, is highly site-specific and may increase the difficulty of developing a specific breccia pipe. A full list of required permits for mine development is included in Attachment B-1.

B.7 FUTURE TRENDS AND ASSUMPTIONS

B.7.1 Commodities of Interest

The scope of this RFD analysis incorporates only locatable minerals; salable and leasable resources are not considered because they would not be subject to the proposed withdrawal. The primary mineral commodity of interest in the area will continue to be uranium. Other precious metals and rare earth metals could be recovered from breccia pipe deposits concurrent with uranium mining, including gold, silver, copper, and vanadium. However, values from recovery of these metals are assumed to not be sufficient to drive mine development.

B.7.2 Commodity Markets

The economics of mining in the proposed withdrawal area will continue to be driven by the relationship between uranium production costs and market price. While production costs can be controlled or anticipated through management and technology, the significant unknown factor will continue to be the price of uranium. The overall profitability of an operation, and hence the level of activity at the prospecting, exploration, and mining phases, for development of breccia pipes will be closely related to the price of uranium.

Uranium has been subject to constant variations in price, supply, and demand over the past half-century as a result of several factors, including the amount of uranium supplies worldwide, dollar value, and energy demand. Figure B-3 illustrates the relationship between uranium requirements (or demand, represented by the blue line) and uranium production (or supply, represented by the red line). The peak production of uranium occurred around 1979–1980.

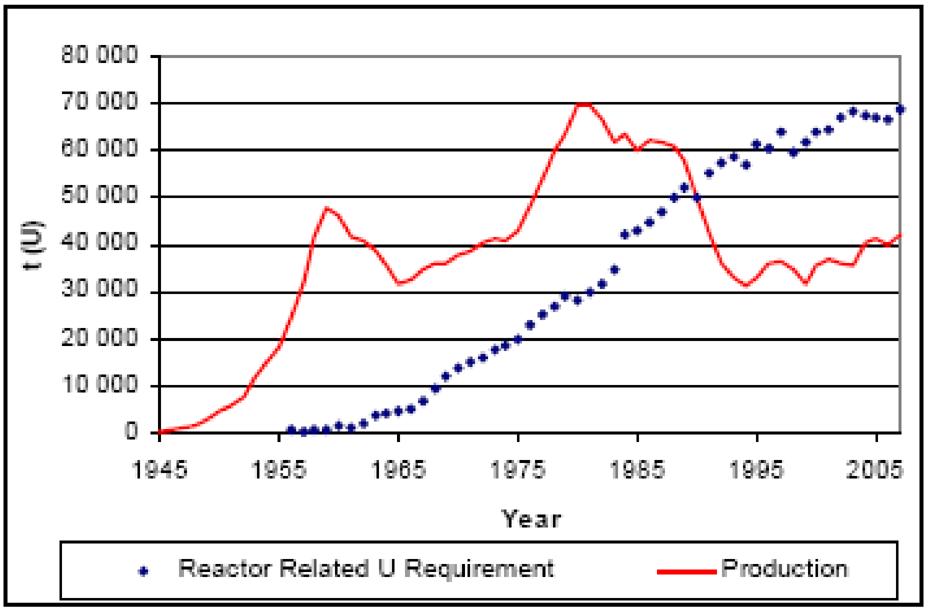

Figure B-3. Worldwide annual production and reactor-related requirements (1945–2005) (Source: International Atomic Energy Agency 2009).[2]

Worldwide uranium demand has climbed steadily since the 1950s, more recently leveling off at approximately 70,000 tons of uranium per year. Annual uranium production far exceeded uranium demand until about 1990. Since 1990, driven by a collapse of uranium commodity prices (see Figure B-3), production has been significantly less than demand; worldwide, uranium stockpiles produced before 1990, rather than current production, are being used to fully meet uranium demand.

Figure B-4 displays uranium prices (U.S. dollars per pound [$/lb]) on the spot market over the past 15 years. Uranium prices throughout the 1990s remained low, less than $20/lb, following the collapse of uranium commodity prices in the 1980s and the influx of various stockpiled sources of uranium into the marketplace, including weapons-grade enriched uranium from the former Soviet Union and U.S.-held government stockpiles. Only since 2003 have uranium prices risen. The peak in 2007 was driven largely by global speculation, and prices have since settled to approximately $40/lb.

[2] U = uranium.

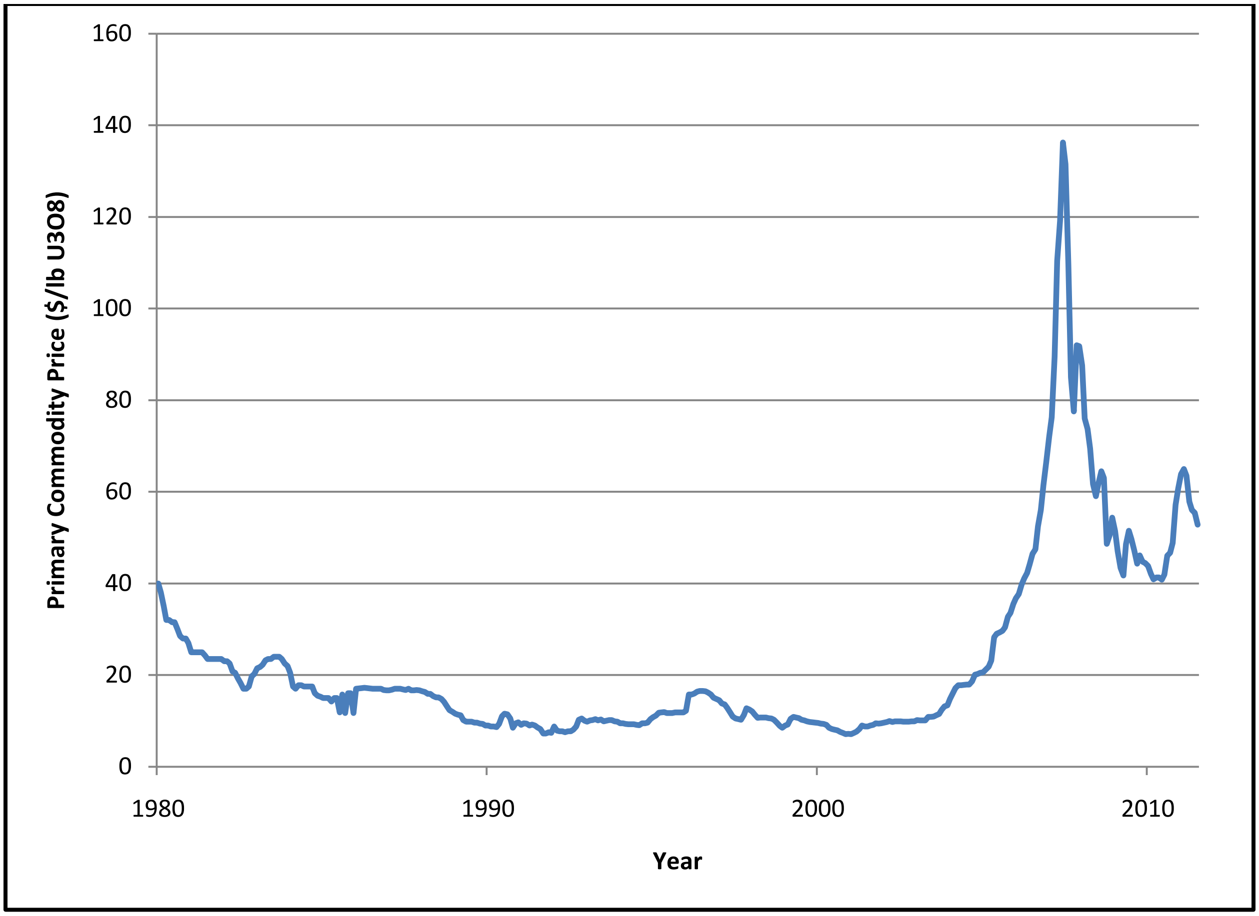

Figure B-4. Historical uranium market prices (U.S. dollars per pound) (Source: International Monetary Fund 2011).

It should be noted that the spot market may not be an accurate indicator of long-term contract prices for uranium, which are what determine the economics of mining specific breccia pipe ore bodies. For the purposes of the RFD scenarios, it is assumed that uranium prices will remain above this level. Historically, price changes have been the primary reason for mining companies to operate under interim management; therefore, based on the assumption that prices will remain above this level, the mines considered in the RFD are not likely to operate under interim management.

The approach of assuming a floor for uranium commodity prices equal to current levels was considered appropriate because this price level is relatively conservative and therefore does not overestimate the economic impacts of mining based on short-term price spikes, and because at this price it is known that mining uranium in breccia pipe deposits is economically viable. While the exact dollar amount for uranium is not expected to remain constant over the next 20 years, the assumption is that prices would generally remain sufficient to support mining operations. Given potential changes in demand, supply, and unforeseen world events, exact price changes simply cannot be predicted with any degree of accuracy.

In the past, uranium prices have been subject to wide fluctuations, as seen during the speculative period that peaked in 2007, when spot prices reached $140/lb and long-term prices approached $100/lb. During the previous 20 years, long-term and spot prices were around $10/lb. The RFD assumes that prices will remain constant at current levels for the next 20 years. Prices play a critical role in the extent to which uranium deposits are developed in the United States and in other parts of the world. Relatively higher prices would be anticipated to stimulate additional mining, from both new and existing mines. Additional production would be expected to act as a moderating force on additional price increases. Deviations from this assumption could affect several parts of the RFD, such as the total number of mines and the total uranium mined, which would then carry through to the evaluation of impacts. This in turn would drive greater differences in development between alternatives.

One of the drivers of uranium prices is world supply, both from producing uranium mines and secondary stockpiles. The top five uranium producers (Kazakhstan, Canada, Australia, Namibia, and Russia) accounted for 75% of world supply in 2008 and 85% in 2009 (World Nuclear Association 2010a). The United States produces about 3% of world supply. An increase in production by the top producers would be expected to put downward pressure on prices. These changes would affect the other impacts described in the EIS. For example, reduced mining activity may lead to reduced impacts under the No Action Alternative, such as fewer particulate matter emissions, less disturbance of habitat and cultural, historical, or Indian resources, and less displacement of recreation activity. This in turn reduces the differences between the No Action Alternative and any of the action alternatives (B, C, or D).

Total world uranium production met 68% of demand in 2008, and 76% in 2009 (World Nuclear Association 2010a); demand in excess of supply can be expected to bid up prices. Plans for new reactors could also increase demand and bid up prices. As of October 2010, the United States had 104 operable reactors, with one more reactor under construction, and nine planned and 22 proposed over the next 20 years. Worldwide, there were 441 reactors operable in October 2010, with 58 more under construction, and 152 planned and 337 proposed over the next 20 years (World Nuclear Association 2010b). This increase in demand may be met by current supply, or it may outstrip supply and bid up prices.

B.7.3 Technology

In general, advances in technology can improve mineral exploration and development success. With respect to exploration, advances in geophysical and geochemical survey methods, tools, and procedures will continue as more and better equipment is made available. The effect of these advances will be a more accurate and rapid evaluation of regional and local areas, with better discrimination of target areas and a more accurate assessment of a deposit’s potential. With respect to mining and mineral processing efficiency, improvements in technology, coupled with experience, can decrease costs, partially offsetting declines in commodity markets or allowing for lower cutoff grades when identifying potential ore deposits.

With respect to breccia pipe uranium deposits, such changes may not be a major factor in identifying new deposits since northern Arizona breccia pipe deposits are not marginal in terms of percent uranium, being already higher in grade than 85% of uranium deposits worldwide. Where uranium mineralized deposits exist, they can be classified as either minable or not, without having to rely on anticipated improvements in technology.

B.7.4 Industry Mining and Milling Capacity

Underground mining of uranium requires a high degree of specialized expertise, a large capital investment in equipment and infrastructure, and available mill capacity for processing of ore. Although multiple companies are actively pursuing exploration associated with breccia pipe uranium deposits in the proposed withdrawal area, only a single company is currently engaged in actual mining activities. Because of the high degree of specialization and overhead, there is unlikely to be a large number of companies actively engaged in mining activities at any one time.

Furthermore, the average life span of a breccia pipe uranium mine is relatively short, generally lasting only about 5 years from development through operations and reclamation. Investing large amounts of capital in redundant equipment is not economically viable when existing equipment can be effectively moved from mine to mine after only a few years of operation. The inherent economic limitations in the uranium industry will tend to limit the concurrent development of mines. This limitation is discussed in more detail under Alternative A.

B.7.5 Legislative Changes

There are several areas of legislative change that may affect how the hardrock mineral resources in the proposed withdrawal area are developed. The first is the ongoing effort to amend, repeal, or reform the Mining Law. This could result in anything from simply leaving it as is to a complete restructuring into a leasing royalty system similar to what is now used for coal or oil and gas. The effect of major changes in the Mining Law on mineral activity in the proposed withdrawal area, while uncertain, would likely be a decrease in the amount of exploration activity and hence mine development, at least in the short term, as operators adjust to the new requirements. A perhaps more extensive effect would be a decrease in the ultimate number and size of mines that could be developed if a royalty on mineral production created a corresponding increase in operating costs, raising the cut-off ore grade. For the purposes of this analysis, it is assumed that the Mining Law would not be changed significantly, the right of self-initiation would be maintained, and there would be no federal royalty system imposed. It is also assumed that while the exploration and mine review and approval process would continue to receive greater scrutiny and legal challenge, claimants or operators would still be able to obtain the necessary approvals.

Changes in the way mining property and production are taxed could also have a substantial effect on the viability of individual operations. No changes in state tax schedules are anticipated. In this analysis, it is assumed that there will be no federal royalty.

Changes in state environmental permitting through ADEQ, ADWR, and EPA could also have a substantial effect on the viability of individual operations. No major change to the present state regulatory framework is anticipated.

B.8 FUTURE LOCATABLE MINERAL EXPLORATION AND DEVELOPMENT

Estimates of reasonably foreseeable future locatable mineral exploration and development are presented below for each alternative, starting with the No Action Alternative. These projections include estimates of the following:

- Number of mines,
- Amount of exploration activity,
- Miles of new roads,
- Miles of power lines,
- Number of haul trips,
- Acreage of surface disturbance, and
- Water use.

The time frame used for the projection of future mineral activity is 20 years. This is for several reasons: first, the Proposed Action (Alternative B) is for a 20-year withdrawal (the limit of the Secretary's withdrawal authority), and using this time period allows for a direct comparison between alternatives; and second, the longer the time frame used for analysis purposes, the more speculative and less reliable the projections of future activity. However, it should be noted that activity of the same type and rate may proceed beyond the 20-year time frame.

B.8.1 Alternative A: No Action (No Withdrawal)

The notice of proposed withdrawal segregated the locatable minerals in the study area, preventing the location and entry of any new mining claims for a period of 2 years (July 21, 2009 to July 21, 2011); the subsequent emergency withdrawal extended this for an additional 6 months, to January 20, 2012. Under Alternative A, the No Action Alternative, the lands would again be open to location of new mining claim upon termination of the emergency withdrawal. Mineral exploration and development on any existing or new mining claims would proceed under the applicable BLM or Forest Service regulatory requirements.

Future Locatable Mineral Exploration and Development

The number of potential mines can be grouped into five categories, similar to those shown in Table B-1:

- Mines that are currently operating under approved plans of operation;
- Mines that may be developed from known mineralized breccia pipes with reliable estimated uranium resources,
- Mines that may be developed from known mineralized breccia pipes where uranium resources have yet to be estimated,
- Mines that may be developed from known breccia pipes for which the level of mineralization has yet to be determined, and
- Mines that may be developed from breccia pipes that are currently undiscovered.

Currently Approved Mines

Three mines within the proposed withdrawal area (Pinenut, Kanab North, and Canyon) were approved in the late 1980s. These mines still contain uranium resources but are operating under the interim management plans contained in their approved mining plans of operation and are not currently producing uranium ore. An additional mine, Arizona 1, was approved and developed in 1988, but no ore was mined until late 2009. Pinenut, Kanab North, and Arizona 1 are located within the North Parcel, while Canyon is located within the South Parcel. The Kanab North mine holds an approved plan of operations, with some remaining uranium resources. For purposes of this RFD scenario, it is assumed that the Kanab North mine would resume ore production. Development work at the Canyon mine included sinking of the main shaft approximately 50 feet before the operator decided to begin operating under the interim management plan contained in its approved mining plan of operations.

- ➢ Assumption: All four mines with approved plans of operation will resume production under the proposed withdrawal.

Known Mineralized Breccia Pipes with Estimated Uranium Resources

A further 26 confirmed breccia pipes within the proposed withdrawal area are known to have some level of mineralization (see Table B-3). Of these, seven have been confirmed to have uranium resources. Uranium reserve estimates have been officially published for the EZ-1 and EZ-2 breccia pipes (Scott Wilson Mining 2009); uranium reserve estimates for the remaining five breccia pipes (DB, Findley NW, Findley SE, Rim, and What) were reportedly conducted internally by Energy Fuels Nuclear and are considered preliminary (personal communication, Spiering 2010a). For the purposes of this analysis, it is assumed that under Alternative A, these breccia pipes would be mined. All seven breccia pipes with estimated uranium resources are located within the North Parcel.

- Assumption: The seven breccia pipes with estimated uranium resources will be mined under the proposed withdrawal.

Known Mineralized Breccia Pipes with No Estimate of Uranium Resources

Uranium resources have reportedly not been calculated for the remaining 19 confirmed mineralized breccia pipes shown in Table B-3 (personal communication, Spiering 2010a). The presence of mineralization is not a guarantee of significant uranium resources (typically considered to be resources with more than 50 tons U_3O_8). Previous research suggests that less than 10% of mineralized breccia pipes might be economically viable (Weinrich and Sutphin 1988); further discussions with industry experts (personal communication, Hefton 2010; personal communication, Pillmore 2010a; personal communication, Spiering 2010b; personal communication, Turner 2010) did not lead to a refinement of this assumption.

For the purposes of this analysis, it is assumed that 15% of these known mineralized breccia pipes could be economical to mine; a discussion of the use of this assumption is included later in this section under Undiscovered Uranium Reserves. This yields an additional three breccia pipes (i.e., 15% of the 19 mineralized breccia pipes) that probably would be mined. It is assumed that of the three breccia pipes, two would be located in the North Parcel and one would be located in the South Parcel.

- Assumption: An additional 19 breccia pipes are confirmed to be mineralized.
- Assumption: An estimated 15% of mineralized breccia pipes contain minable amounts of uranium, yielding a total of three mines resulting from the 19 confirmed mineralized breccia pipes under the proposed withdrawal.

Known Breccia Pipes with Undetermined Mineralization

Only a fraction of breccia pipes contain significant levels of mineralization, and only a fraction of these mineralized breccia pipes contain economically viable quantities of uranium ore; however, a reasonable percentage for this assumption is difficult to obtain. In addition to a review of available literature, discussions were undertaken with industry experts in an attempt to ascertain a reasonable value. Three possible values are presented below; it should be noted that the industry experts consulted believe that this is a difficult number to know with any accuracy.

- Previous research has suggested that perhaps only 8% of breccia pipes contain mineralization, and, as previously noted, that perhaps only 10% of mineralized breccia pipes might be economically viable (Weinrich and Sutphin 1988). This suggests that approximately 1 out of every 100 undetermined breccia pipes might eventually be suitable for mining.
- One industry expert suggested a range: perhaps 1 to 5 out of every 100 breccia pipes might yield an economic ore body (personal communication, Hefton 2010).
- A third approach was suggested that used published data to estimate percentages. Different estimates of the number of breccia pipes have been published for various portions of northern Arizona. The most comprehensive inventory of breccia pipes across the northern Arizona region comes from Wenrich and Sutphin (1989). Wenrich and Sutphin (1989) mapped 1,296 breccia pipes across much of northern Arizona, inclusive of the proposed withdrawal area. Historically, in this same area there have been 14 breccia pipes mined (or developed with plans to be mined). These include, from 1951–1969, the Orphan, Hack Canyon, Ridenour, Chapel, and Riverview mines, and during the 1980s, the Hack 1, Hack 2, Hack 3, Hermit, Pinenut, Kanab North, Arizona

1, Pigeon, and Canyon mines. These data suggest that there is approximately 1 productive mine for every 100 identified breccia pipes.

Based on these estimates, for the purposes of the RFD scenarios, it assumed that 1 out of every 100 discovered breccia pipes could eventually be mined; however, as with any such predictive approach, there is considerable uncertainty. This estimate may not be indicative of future conditions should other variables change, such as a drastic up- or downturn in the uranium market.

In the case of the 10 confirmed breccia pipes within the proposed withdrawal area whose level of mineralization has yet to be determined (see Table B-3), for the purposes of the RFD analysis, it is unlikely that any of these breccia pipes would be mined.

- Assumption: An additional 10 breccia pipes are confirmed within the proposed withdrawal area, but it is not known whether they are mineralized or not.
- Assumption: An estimated 1% of all breccia pipes contain minable amounts of uranium, yielding no mines resulting from the 10 confirmed breccia pipes under the proposed withdrawal.

Undiscovered Uranium Resources

Numerous estimates of the amount of uranium resources have been calculated for portions of northern Arizona over the past three decades. The most recent of these studies was conducted by the USGS specifically for the proposed withdrawal area in order to support the analysis of a potential withdrawal (USGS 2010).

The 2010 USGS estimate focused on the undiscovered uranium endowment; the term uranium endowment is defined as the uranium occurring in rock that exceeds 0.01 percent grade U_3O_8. Note that uranium amounts are typically referred to as "tons U_3O_8," which refers to the amount of processed uranium a mine can yield. The actual ore that must be removed from the mine and taken to the mill is much greater; for northern Arizona breccia pipes, the amount of ore that must be removed is typically 100 to 200 times the amount of processed uranium, depending on the ore grade. The 2010 USGS estimate is primarily based on a USGS study completed in 1990 (Finch et al. 1990). The 1990 study ranked various areas within northern Arizona for favorability for breccia pipe uranium deposits; the entire proposed withdrawal area is within the zone termed "Favorable Area A," which is the area of highest favorability for uranium deposits.

The 1990 estimate of uranium endowment was based on a well-studied control area of 141 square miles termed the "Hack-Pinenut" control area (located within the North Parcel of the proposed withdrawal area). The USGS reviewed borehole data collected during drilling and development, as well as uranium reserve estimates from Energy Fuels Nuclear, the sole company producing uranium in the area during the 1980s. Based on an understanding of the Hack-Pinenut control area, probabilities of breccia pipe size, density, and ore grade were extrapolated to the rest of the northern Arizona study area. The 1990 USGS report estimated 112.4 tons U_3O_8 existed per square mile. The 2010 USGS report adjusted this number based on discrepancies in area calculations, with a result of 96.6 tons U_3O_8 per square mile.

Applied to the 1,689 square miles of the proposed withdrawal area, this yields an estimated undiscovered uranium endowment of 163,380 tons U_3O_8 (USGS 2010). This estimate was further divided by USGS into undiscovered uranium endowment under existing claims and undiscovered uranium endowment not under existing claims; this subdivision was arrived at solely by applying the percentage of the proposed withdrawal surface area covered by existing claims. The 2010 USGS estimated undiscovered uranium endowment is shown in Table B-4.

The 1990 estimate of resources within the Hack-Pinenut control area included a statistical assessment of the likely uranium endowment within the area; the estimate of 96.6 tons U_3O_8 per square mile (and thus the estimate of 163,380 tons U_3O_8 for the proposed withdrawal area as well) is based on the statistical average of estimated uranium endowment within the Hack-Pinenut control area. A statistical range was also calculated during the 1990 estimate in order to provide the bounds of the 90% confidence interval. In other words, there is a 90% probability that the real-world uranium endowment will be within this range. Applied to the proposed withdrawal area, there is a 90% probability that the undiscovered uranium endowment will be between 42,900 tons U_3O_8 and 339,000 tons U_3O_8 (personal communication, Otton 2010a). The average value of 163,380 tons U_3O_8 reflects the statistically most likely value for the undiscovered uranium endowment, based on the available data. This relatively large range reflects the inherent uncertainty involved in estimating the undiscovered uranium endowment.

Table B-4. Estimated Undiscovered Uranium Endowment*

Proposed Withdrawal Parcel	Undiscovered Uranium Endowment under Existing Claims (tons U_3O_8)	Undiscovered Uranium Endowment Not under Existing Claims (tons U_3O_8)	Total Undiscovered Uranium Endowment (tons U_3O_8)
North	45,808	46,136	91,944
East	425	21,832	22,257
South	14,403	34,776	49,179
Total	**60,636**	**102,774**	**163,380**

Source: USGS (2010:Chapter A, Table 8).

* It should be noted that since the 2010 USGS report was prepared, the number of claims in the proposed withdrawal area has decreased considerably and the distinction between claimed and unclaimed lands is no longer applicable.

As noted above, the 2010 USGS estimate of uranium resources within the proposed withdrawal area focuses specifically on the uranium "endowment," a term explicitly defined as the uranium occurring in rock that exceeds 0.01 percent grade U_3O_8. The uranium endowment would consist of mineralized breccia pipes, but these are not necessarily breccia pipes with uranium grades that are economical for mining. Historically, the percent grade of uranium from ore bodies that have been or could be mined ranges from 0.53% to 1.08%, as shown in Table B-5.

Table B-5. Percent Ore Grade for Existing and Historic Mines

Proposed Withdrawal Parcel	Mine	% Uranium of Ore
North	Arizona 1	0.68
	Pigeon	0.643
	Hack 1	0.530
	Hack 2	0.704
	Hack 3	0.504
	Hermit	0.760
	Kanab North	0.53
	Pinenut	1.02
South	Canyon	1.08

Source: personal communication, Spiering (2010a).

As mentioned previously, research suggests that less than 10% of mineralized breccia pipes might be economically viable (Weinrich and Sutphin 1988); further discussions with industry experts (personal communication, Hefton 2010; personal communication, Pillmore 2010a; personal communication, Spiering 2010b; personal communication, Turner 2010) did not lead to a refinement of this assumption.

Whereas historically, ore grades mined from the proposed withdrawal area have been greater than 0.5% U_3O_8, this is not necessarily the case for future uranium mines. Based on estimates of ore grade for the mines with currently approved plans of operation and other known mineralized breccia pipes, ore grades as low as 0.23% U_3O_8 are expected to be mined. The 10% estimate referenced above was increased to 15% to account for the lower grades of uranium that might be economically mined today, compared with those mined in 1988. A 2009 industry report by the American Clean Energy Resources Trust (ACERT) estimated that the average size of a typical breccia pipe uranium deposit is 3 million pounds U_3O_8 (ACERT 2009; personal communication, Spiering 2010b). Five mines in the proposed withdrawal area have been fully depleted of their uranium ore, or at least to the extent to which mining is economically feasible: Hack 1, Hack 2, Hack 3, Hermit, and Pigeon. The uranium ore bodies in these mines ranged from approximately 552,000 pounds U_3O_8 (Hermit) to approximately 7 million pounds U_3O_8 (Hack 1), with an average of approximately 3.1 million pounds (personal communication, Spiering 2010a). Based on these historic data, it appears that the 2009 ACERT estimate of 3 million pounds U_3O_8 (1,500 tons U_3O_8) for a typical breccia pipe ore body is reasonable. The number of mines that could be proposed to extract the entire estimated undiscovered economically viable uranium resource (i.e., 15% of the endowment) is shown in Table B-6.

Table B-6. Estimated Number of Mines Required to Extract Undiscovered Uranium Endowment

Proposed Withdrawal Parcel	Total Undiscovered Economically Viable Uranium Resource* (tons U_3O_8)	Number of Mines†
North	13,792	9
East	3,339	2
South	7,377	5
Total	**24,508**	**16**

* Assumed to be 15% of the undiscovered uranium endowment.

† Based on average of 1,500 tons U_3O_8 per typical breccia pipe ore body, rounded.

- Assumption: The USGS has estimated that the statistical average uranium endowment (greater than 0.01 percent ore grade) within the proposed withdrawal area is 163,380 tons U_3O_8.
- Assumption: Only a portion of the uranium endowment would be economical to mine. This portion has been estimated in the past at 10%, but was increased to 15% to account for likely lower ore grades being economical to mine than was the case historically. This yields 24,508 tons U_3O_8 as yet undiscovered within the proposed withdrawal area.
- Assumption: Based on the historical average amount mined per breccia pipe, a typical breccia pipe mine would yield 1,500 tons U_3O_8.
- Assumption: Based on these conditions, the undiscovered uranium endowment would yield 16 mines.

Industry Limitations on Active Mines

Given an unlimited time frame and favorable economic conditions, it could be assumed that almost all economically viable uranium could eventually be mined from the proposed withdrawal area. However, the large number of mines needed to do so could not occur all at once, nor would they all occur over the 20-year time frame of the present analysis. Rather, the normal industrial cycle would tend to restrict the number of mines in production at any one time, based on market economics, available equipment, personnel, and expertise.

The mining industry has prepared an estimate of the economic impacts of mines within the proposed withdrawal area (ACERT 2009). The 2009 ACERT report proposes that a typical mine has a 5-year life cycle: planning and permitting (1 year), development (1 year), production (2 years), and reclamation (1 year).

The 2009 ACERT report estimated the number of mines likely to occur within northern Arizona over a 42-year period, based on a 5-year life cycle and the assumption that no more than six mines would ever be in production at any one time. Several industry experts were contacted regarding this assumption, including two who had consulted on the ACERT analysis. It was determined that the ACERT assumption of a maximum of six mines in simultaneous production was made based on economic considerations, including required cash flow and the local economic repercussions of multiple mining operations (personal communication, Hefton 2010; personal communication, Pillmore 2010a; personal communication, Spiering 2010b). Discovery rate of breccia pipes and mill capacity were not considered to be limiting factors. The White Mesa Mill, located in Blanding, Utah, licensed to handle 2,000 tons of uranium ore per day, was considered likely to handle increased production from northern Arizona, and additional capacity is expected when the Piñon Ridge facility (located in Montrose County, Colorado) comes on line, potentially in 2012. The Piñon Ridge facility is expected to eventually process up to 1,000 tons of uranium ore per day (Energy Fuels Resources 2010). For the purposes of analysis, it is assumed that ore will be shipped to and processed at the White Mesa Mill; however, other mills may also see changes in activity based on specific contracts and business relationships made with uranium mines within the proposed withdrawal area. The transport of ore to mills other than White Mesa is not expected to result in significantly different resource impacts or substantially change the analysis of impacts.
The assumption that six breccia pipes might be in production at any one time was compared with the historic operations during the 1980s and the current number of breccia pipes that are likely to move toward development. Historically, seven breccia pipes were developed during the 1980s: three breccia pipes at the Hack Complex, along with the Hermit, Pinenut, Kanab North, and Pigeon breccia pipes. Based on known production schedules, it is likely that at several periods up to five of these breccia pipes were being mined at any one time. Currently, there are four breccia pipes with approved plans of operation and an additional three breccia pipes (EZ-1, EZ-2, What) for which plans have been filed. Based on these historic and current observations, it is reasonable to estimate an industrial capacity of four to seven breccia pipes being mined at any one time. For the purposes of the RFD, the assumption that six breccia pipes could be mined at any one time was used.

A schedule was constructed for the next 20 years, with six mines being in production at any one time; this includes the existing Arizona 1, Pinenut, Kanab North, and Canyon mines, as well as yet-unidentified new mines. This schedule suggests that 61 mines could be in production over the next 20 years, as shown in Figure B-5. However, based on additional limitations, this estimate of new mines was considered a maximum and was further reduced, as described in the next section.

Uncertainty Factors and Estimate of Mine Life Cycle

COMMODITY PRICES

Commodity prices drive mineral exploration and mine development, and historically the mining of breccia pipes in northern Arizona has been no exception. As shown in Table B-2, the 1980s were characterized by anywhere from three to five mines producing uranium at any one time, with the peak occurring in 1987. However, commodity prices for uranium were also steadily eroding throughout the 1980s. There is not necessarily an immediate and direct relationship between spot commodity prices and mine activity; long-term prices and contract prices play a much more important role in mine development. However, the halving of uranium prices from $23/lb in 1981 to $10/lb by the 1990s took its toll, and four mines with approved plans of operation ceased or suspended ore extraction or development and interim management plans were implemented.

	AZ-1	Pinenut	Kanab North	Canyon	New Mine 1	New Mine 2	New Mine 3	New Mine 4	New Mine 5	New Mine 6	New Mine 7	New Mine 8	New Mine 9	New Mine 10	New Mine 11	New Mine 12	New Mine 13	New Mine 14	New Mine 15	New Mine 16	New Mine 17	New Mine 18	New Mine 19	New Mine 20	New Mine 21	New Mine 22	New Mine 23	New Mine 24	New Mine 25	New Mine 26	New Mine 27	New Mine 28	New Mine 29	New Mine 30	New Mine 31	New Mine 32	New Mine 33	New Mine 34	New Mine 35	New Mine 36	New Mine 37	New Mine 38	New Mine 39	New Mine 40	New Mine 41	New Mine 42	New Mine 43	New Mine 44	New Mine 45	New Mine 46	New Mine 47	New Mine 48	New Mine 49	New Mine 50	New Mine 51	New Mine 52	New Mine 53	New Mine 54	New Mine 55	New Mine 56	New Mine 57
Year 1	P	P	P	P	P	P	D	I	I	I	I	I																																																	
Year 2	R	P	P	P	P	P	P	D	D	D	D	D	I																																															
Year 3		R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I																																											
Year 4							R	P	P	P	P	P	P	D	D	D	D	D	I																																										
Year 5								R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I																																					
Year 6													R	P	P	P	P	P	P	D	D	D	D	D	I																																				
Year 7														R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I																															
Year 8																			R	P	P	P	P	P	P	D	D	D	D	D	I																														
Year 9																				R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I																									
Year 10																									R	P	P	P	P	P	P	D	D	D	D	D	I																								
Year 11																										R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I																			
Year 12																															R	P	P	P	P	P	P	D	D	D	D	D	I																		
Year 13																																R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I													
Year 14																																					R	P	P	P	P	P	P	D	D	D	D	D	I												
Year 15																																						R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I							
Year 16																																											R	P	P	P	P	P	P	D	D	D	D	D	I						
Year 17																																												R	R	R	R	R	P	P	P	P	P	P	D	I	I	I	I	I	
Year 18																																																	R	P	P	P	P	P	P	D	D	D	D	D	I
Year 19																																																		R	R	R	R	R	P	P	P	P	P	P	D
Year 20																																																							R	P	P	P	P	P	P

Assumes six mines in production at any given time
I = Initial permitting and planning
D = Development of mine site
P = Production
P = Production
R = Reclamation

Figure B-5. Estimated number of mines able to be supported by industry based on ACERT study.

As shown in Figure B-4, uranium prices began to recover at the end of the 1990s. The past decade has been characterized by a peak in uranium prices driven in part from speculation, with prices peaking near $140/lb in 2007 and settling near current price levels at $40/lb. The effect of uranium price recovery has been a resurgence in exploration in the proposed withdrawal area as well as the resumption of mining in the Arizona 1 Mine, although no new breccia pipes have been developed to date. The historical response to price fluctuations in the 1980s and during the past decade both illustrate how important uranium prices are to driving exploration, mine development, and production. The historical data also show how much variability can occur in commodity prices even over several years. Future commodity prices and price fluctuations are a source of uncertainty in this analysis. The spot price of $40/lb is representative of a level sufficient to support economically viable mine operations. While the exact dollar amount is not expected to remain constant, the RFD activity estimate is based on the assumption that prices would generally remain sufficient to support mining operations. To do otherwise would require speculation not only on future economic conditions but on other global events that could affect price but simply cannot be predicted with any degree of accuracy. Similarly, the estimate of the industrial capacity to maintain six mines in production at any one time is assumed to be primarily driven by uranium commodity prices and will remain similar over the 20-year period of analysis.

NATIONAL ENVIRONMENTAL POLICY ACT REVIEW

The BLM and Forest Service will likely authorize most uranium exploration activities under a notice or notice of intent, neither of which is considered major federal actions subject to NEPA review. However, the surface managing agency may under some circumstances require the filing of a plan of operations for such activities. In such instances, the overall permitting time for the mine would increase because NEPA analysis would take place before both the exploration and the mining phases. The approval of a plan of operations is a major federal action requiring analysis under NEPA. Preparation of an EA takes on average 1 year. If the surface managing agency determines as a result of preparing the EA that the activities under the plan will significantly affect the quality of the human environment, or if the agency anticipates at the outset that the potential effects of mining will be significant, the agency will prepare an EIS. Preparation of an EIS generally takes on average 2 to 3 years. In addition, there are concurrent state permitting processes that may also take 1 or more years to complete, such as under the Individual APP program. Because of these uncertainties, this RFD analysis assumes a 2-year permitting/planning time frame for future mines.

PRODUCTION TIME FRAME

The production time frame of 2 years used in the 2009 ACERT report was based on analysis of the historic Pigeon mine (personal communication, Spiering 2010b). The Pigeon mine produced approximately 2,800 tons U_3O_8 between 1984 and 1989 (personal communication, Otton 2010b; personal communication, Spiering 2010a). The average mine would produce a little more than one-half the amount produced from Pigeon; therefore, it was assumed that 2 years would be a likely production time frame for the average mine. Several factors suggest a slightly longer production time frame.

Based on the proposed plan of operations for the EZ-1, EZ-2, and What breccia pipes, the production time frame is estimated at 10 years for these three breccia pipes (Denison Mines (USA) Corporation [Denison] 2010). Furthermore, both the proposed EZ-1/EZ-2/What mine and the currently active Arizona 1 mine indicate that approximately 300 to 400 tons of ore per day would be hauled from each mine. The average mine production of 1,500 tons U_3O_8 would likely require 278,000 tons of ore to be removed for processing (based on estimated ore grades for known breccia pipes, discussed further below).
This suggests that 2 to 3 years of production would be required to remove and haul ore for the average mine. Therefore, for the purposes of this analysis, the production time frame for future mines is assumed to be 3 years. In total, the mine life cycle used for the RFD is 7 years: 2 years for planning/permitting, 1 year for mine development, 3 years for production, and 1 year for reclamation.

Based on the modified mine life cycle, it is estimated that industry could sustain up to 37 mines in some stage of production over a 20-year time frame as shown in Figure B-6; this includes the existing Arizona 1, Pinenut, Kanab North, and Canyon mines, as well as 33 as-yet-unidentified new mines.

However, this number of mines is unlikely to be reached, as it exceeds the estimated number of mines (30) that could be sustained by all known and undiscovered uranium resources. As such, the limitation driving the RFD scenario is the available uranium, not the economic or logistical capability of industry to mine ore bodies; for this reason, industrial limitations are not discussed further under the other alternatives.

VALID EXISTING RIGHTS PROCESS

As discussed previously, the assumptions used to develop the RFD scenarios do not reflect any ongoing analysis of a specific mining claim's valid existing rights, nor does the use of these data for the purposes of this analysis presume or supersede any determination of valid existing rights through the normal administrative process, which occurs independent of the RFD analysis and the EIS. The assumption stated above—that the typical mine would require a 2-year permitting/planning time frame—does not incorporate any part of the administrative process to verify or establish valid existing rights that is required by BLM and USFS before authorizing surface disturbing activities on withdrawn lands.This process could significantly lengthen the planning/permitting time frame for mining operations under any of the action alternatives and represents a factor of uncertainty in the mine life cycle used for this RFD analysis.

INTERIM MANAGEMENT

All approved mining plans of operation on BLM-administered land contain an interim management plan, in the event an operator chooses to temporarily suspend production. Three mines in the proposed withdrawal area are currently operating under interim management plans, primarily as the result of historic declines in uranium prices. As discussed previously, an assumption is made in this RFD that uranium prices will remain at or above current levels over the period of analysis, and therefore there will be a continued interest in uranium mining. Therefore, interim management of mines with approved plans of operation is not considered as part of RFD analysis, but it does represent a factor of uncertainty in the proposed mine life cycle.

- Assumption: Industry reports indicate that up to six breccia pipes might be mined at any one time, based on economics and cash flow. In the 1980s, up to five mines were producing at any one time. Based on current conditions, seven breccia pipes are being mined or are being developed. Considering all sources, it was assumed that six breccia pipes might be mined at any one time.
- Assumption: The average mine life cycle will consist of 7 years: 2 years for planning/permitting, 1 year for mine development, 3 years for production, and 1 year for reclamation. Reclamation success could take several additional seasons.
- Assumption: Based on these conditions, industry has the capacity to support up to 37 mines over the next 20 years.

	AZ-1	Pinenut	Kanab North	Canyon	New Mine 1	New Mine 2	New Mine 3	New Mine 4	New Mine 5	New Mine 6	New Mine 7	New Mine 8	New Mine 9	New Mine 10	New Mine 11	New Mine 12	New Mine 13	New Mine 14	New Mine 15	New Mine 16	New Mine 17	New Mine 18	New Mine 19	New Mine 20	New Mine 21	New Mine 22	New Mine 23	New Mine 24	New Mine 25	New Mine 26	New Mine 27	New Mine 28	New Mine 29	New Mine 30	New Mine 31	New Mine 32	New Mine 33	New Mine 34	New Mine 35	New Mine 36	New Mine 37	New Mine 38	New Mine 39	New Mine 40	New Mine 41	New Mine 42	New Mine 43	New Mine 44	New Mine 45	New Mine 46	New Mine 47
Year 1	P	I	I	I	I	I	I																																												
Year 2	R	I	I	I	I	I	I																																												
Year 3		D	D	D	D	D	D																																												
Year 4		P	P	P	P	P	P	I	I	I	I	I	I																																						
Year 5		P	P	P	P	P	P	I	I	I	I	I	I																																						
Year 6		P	P	P	P	P	P	D	D	D	D	D	D																																						
Year 7		R	R	R	R	R	R	P	P	P	P	P	P	I	I	I	I	I	I																																
Year 8								P	P	P	P	P	P	I	I	I	I	I	I																																
Year 9								P	P	P	P	P	P	D	D	D	D	D	D																																
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Year 13														R	R	R	R	R	R	P	P	P	P	P	P	I	I	I	I	I	I																				
Year 14																				P	P	P	P	P	P	I	I	I	I	I	I																				
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Year 17																										P	P	P	P	P	P	I	I	I	I	I	I														
Year 18																										P	P	P	P	P	P	D	D	D	D	D	D														
Year 19																										R	R	R	R	R	R	P	P	P	P	P	P														
Year 20																																P	P	P	P	P	P														

Assumes six mines in production at any given time
I = Initial permitting and planning (assumes two years)
D = Development of mine site (assumes one year)
P = Production (assumes three years)
R = Reclamation (assumes one year)

Figure B-6. Estimated number of mines able to be supported by industry.

Reasonably Foreseeable Development under Alternative A—Number of Mines

The various estimates presented above are summarized in Table B-7. Under Alternative A, reasonably foreseeable uranium mining would occur not only from existing approved mines (four mines) and from confirmed mineralized breccia pipes (10 mines) but also from further exploration and development of the undiscovered uranium endowment within the proposed withdrawal area (potentially 16 mines) over an unlimited time frame. Based on the available information and assumptions, it appears that the amount of available uranium resource is the limiting factor for the number of mines that might be developed.
As such, the RFD scenario for the potential number of plans of operation that could be proposed over the next 20 years is 30: 21 in the North Parcel, two in the East Parcel, and seven in the South Parcel.

Table B-7. Alternative A—No Withdrawal, Estimated Number of Mines (20-Year Time Frame)

	North Parcel	East Parcel	South Parcel	Total
A) Existing Mines	3	0	1	**4**
B) Mines Associated with Mineralized Breccia Pipes with Estimated Uranium Resources	7	0	0	**7**
C) Mines Associated with Mineralized Breccia Pipes with No Estimated Uranium Resources	2	0	1	**3**
D) Mines Associated with Breccia Pipes with Undetermined Mineralization	0	0	0	**0**
E) Number of Mines Anticipated to Extract Estimated Undiscovered Uranium Resources	9	2	5	**16**
F) Reasonably Foreseeable Development under Alternative A	21	2	7	**30**

A) Pinenut, Kanab North, Arizona 1, and Canyon.
B) Assumes that all mineralized breccia pipes with estimated uranium resources could be developed.
C) Assumes that 15% of the mineralized breccia pipes without uranium reserve estimates could be developed.
D) Assumes that 1% of the breccia pipes with undetermined mineralization could be developed.
E) Based on 15% of the USGS (2010) undiscovered uranium endowment estimate and an average 1,500 tons U_3O_8 per mine.
F) RFD scenario is assumed to be the sum of existing mines and likely mines associated with known and unknown breccia pipes [A + B + C + D + E].

It is recognized that future proposed mines in the proposed withdrawal area may actually exploit multiple breccia pipes (e.g., EZ-1, EZ-2, What) from a single mine footprint. For the purposes of this analysis, the terms “mine” is understood to refer to the operations needed to develop a single breccia pipe.

- Assumption: The industry capacity to mine uranium over the next 20 years (37 mines) is greater than the amount of mines associated with known breccia pipes and undiscovered uranium resources (30 mines) and therefore is not a limitation.
- Assumption: While in the future, a single mine site might exploit multiple breccia pipes, for the RFD analysis, a “mine” is understood to consist of a single breccia pipe.

Reasonably Foreseeable Development under Alternative A—Exploration Activities

Field investigations associated with new and existing mining claims would continue. Identifying a possible ore body consists of three stages: reconnaissance, prospecting, and exploration. Reconnaissance and prospecting have little surface disturbance, typically consisting of the use of aerial and remote sensing techniques, followed by on-the-ground mapping and surface sampling. Exploration using drill holes and sampling then proceeds where reconnaissance and prospecting results are favorable.

Exploration drilling includes advancing several shallow drill holes (less than 600 feet deep) in order to confirm the presence of a breccia pipe and establish its boundaries. This would be followed by deeper drilling (up to several thousand feet) to confirm the presence of mineralization and the presence and grade of uranium ore. As it is difficult to fully define the extent of an ore body from the surface solely through drilling, exploration or development might also include sinking a shaft in order to directly intercept the ore for further drilling or sampling. Data on the historic drilling conducted by Energy Fuels Nuclear indicate that between 1981 and 1994, there were 683 deep and 1,672 shallow stratigraphic holes drilled across the northern Arizona region, or approximately two to three shallow holes for every deep hole (personal communication, Pillmore 2010b).

The amount of exploration likely to occur in order to lead to the expected number of mines can be estimated from historic data. During the peak exploration period from 1980 to 1988, 528 exploration Notices were submitted to the BLM Arizona Strip District Office. Of these, 384 projects experienced some manner of activity, and 237 projects included exploration drilling (BLM 1990:Table III-6). This exploration accounted for the drilling of 1,211 drill holes (BLM 1990:Table III-6). During this same period, Notices of Intent submitted to the Kaibab National Forest accounted for the drilling of about 900 drill holes, as shown in Table B-8 (personal communication, Schwab 2010).

Table B-8. Amount and Success of Historic Exploration*

Jurisdiction	Historic Exploration Statistic	Amount
BLM – Arizona Strip District Office	Number of exploration projects with drilling	237
	Drill holes	1,211
	Acres disturbed	415.1
Kaibab National Forest	Number of exploration projects†	180
	Number of drill holes	900
Northern Arizona	Ore bodies discovered	11
Statistics Used in RFD Analysis	Average drill holes per project	5
	Average active projects per ore body discovered	38
	Acres disturbed per active project	1.1

* Approximate time range 1980–1988.

† Actual number unavailable; estimate based on BLM data.

During this period (the 1980s and early 1990s), nine ore bodies were discovered and either mined or developed with plans to be mined (Hack 1, Hack 2, Hack 3, Pigeon, Pinenut, Canyon, Arizona 1, Kanab North, and Hermit). In addition, two other breccia pipes were discovered that only recently have published estimates of uranium resources (EZ-1 and EZ-2). In total, 11 ore bodies were discovered as a result of the approximately 400 exploration projects using 2,100 drill holes on lands administered by the Arizona Strip District Office and Kaibab National Forest. Based on these historic data, for every ore body that is economically developed and mined, approximately 40 exploration projects are undertaken, with an average of five drill holes per project.

It should be noted that, for several reasons, historic exploration activity is not necessarily a valid predictor of future exploration activity. Not only are commodity prices fundamentally different, but the technology for remote sensing techniques to identify breccia pipes prior to drilling has improved dramatically since the 1980s. According to industry documents, a recent survey in 2007 consisting of airborne remote sensing followed by exploratory drilling yielded a success rate of 71% for identifying breccia pipes, with many of these breccia pipes actually being mineralized (personal communication, Spiering 2010c, 2010e). Based on these improvements in reconnaissance technology, it is likely that less exploration would be required in the future to locate a minable deposit than is suggested by the historic data. Therefore, it is assumed that for every productive mine, an average of 28 exploration projects might be submitted to the

BLM and Kaibab National Forest, resulting in an average of 140 drill holes. Using this average, the amount of exploration that could be needed to support the expected number of mines in production is shown in Table B-9.

Table B-9. Alternative A—No Withdrawal, Estimated Exploratory Activity Needed to Support Uranium Production (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines*	Number of Exploration Projects†	Number of Drill Holes‡
North	18	504	2,520
East	2	56	280
South	6	168	840
Total	**26**	**728**	**3,640**

* Excludes existing mines (Pinenut, Kanab North, Arizona 1, and Canyon).
† Based on average of 28 exploration projects per ore body discovered.
‡ Based on average of five drill holes per exploration project.

Historic data show that a typical exploration project results in an average of 1.1 acres of surface disturbance (i.e., blading or vegetation clearing). Note that this figure includes any surface disturbance resulting from temporary access road construction. Active clearing and drilling at a typical site is expected to last between 30 and 60 days, although delays are often encountered as a result of weather conditions or drill rig availability. Vehicles present might include a mounted rotary drill rig, drill pipe truck, water trucks, passenger trucks, back hoe, and a geophysical logging truck.

All surface disturbances (i.e., roads, drill pads) are required to be reclaimed prior to release of reclamation bonds. Reclamation at an exploration site typically includes plugging of all drill holes, spreading of any stockpiled cuttings or soil, scarifying and reseeding of disturbed areas, and cleanup of any accidental spills of hazardous materials or petroleum products.

- Assumption: In the 1980s, 417 uranium exploration projects on BLM and Forest Service lands yielded a discovery of 11 minable ore bodies, or 38 exploration projects per future mine.
- Assumption: Based on historic data, there is an average of 5 drill holes per exploration project.
- Assumption: Based on historic data, 1.1 acres of surface disturbance occur per exploration project.

Reasonably Foreseeable Development under Alternative A—Miles of New Roads and Number of Haul Trips

There are two components to be considered for the transportation of ore: the miles of new roads required for new mines and the number of haul trips needed. The miles of new roads were estimated using the following approach. First, it was assumed that the existing road network would be used to the extent possible, with the understanding that some upgrades to existing roads would be required. Next, a series of theoretical mines were placed within the parcels using a random location algorithm within a geographic information system (GIS) database. Once randomly placed, the linear distance from each mine to the nearest existing road was calculated. The average of these linear road segments represents an estimate of the required new road network to support any given mine. An additional factor of 50% was added to this number to account for the sinuosity of roads, under the assumption that in most cases they would not be perfectly linear. On average, the following road lengths were calculated to connect a randomly placed mine to the nearest road: 0.9 mile on the North Parcel, 1.2 miles on the East Parcel, and 0.6 mile on the South Parcel. The estimates are shown in Table B-10; note that only new mines are considered, as the four existing mines (Pinenut, Kanab North, Arizona 1, and Canyon) already have road access.

Table B-10. Alternative A—No Withdrawal, Estimated Miles of New Roads (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines*	New Miles of Road
North	18	16.4
East	2	2.4
South	6	3.6
Total	**26**	**22.4**

* Excludes existing mines (Pinenut, Kanab North, Arizona 1, and Canyon).

No road building was estimated for exploratory drilling since construction of new roads is generally not required to support exploration. Access to exploration sites can usually be accomplished by overland travel, which requires little to no mechanical excavation of the surface route. In cases where new roads are required for exploratory activities, these impacts are already incorporated into the average of 1.1 acres of surface disturbance per exploration project.

The number of ore haul trips is based on the existing operation at the Arizona 1 mine and the proposed mine operations at the EZ-1, EZ-2, and What breccia pipes (Denison 2010). For these mines, approximately 300 to 400 tons of ore are hauled or planned to be hauled per day, with each haul truck capable of handling 25 tons of ore. For the average mine, 1,500 tons U_3O_8 would be produced.
The percent grade of ore in known breccia pipes within the proposed withdrawal area is shown in Table B-11. The average grade of ore is 0.54%, which would result in the need to remove approximately 278,000 tons of ore per mine, for a total of 11,120 haul trips for the average mine. The expected number of haul trips under Alternative A is summarized in Table B-12.

- Assumption: Based on GIS analysis of the existing road network, the average distance to the nearest existing road is 0.9 mile for the North Parcel, 1.2 miles for the East Parcel, and 0.6 mile for the South Parcel.
- Assumption: An average mine will produce 1,500 tons U_3O_8.
- Assumption: The average ore grade in unmined breccia pipes is 0.54%, which indicates that 278,000 tons of ore would be removed per mine.
- Assumption: The average capacity of a haul truck is 25 tons, yielding 11,120 haul trips per mine.

Table B-11. Ore Grade for Existing Mines

Proposed Withdrawal Parcel	Existing Breccia Pipe or Mine	% Uranium of Ore
North	Arizona 1	0.68
	DB	0.44
	EZ-1	0.51
	EZ-2	0.43
	Findlay Tank NW	0.40
	Findlay Tank SE	0.23
	Kanab North	0.53
	Pinenut	1.02
	Rim	0.35
	What	0.25
South	Canyon	1.08
Average		**0.54**

Source: personal communication, Spiering (2010a).

Table B-12. Alternative A—No Withdrawal, Estimated Number of Haul Trips (20-Year Time Frame)

Proposed Withdrawal Parcel	Ore Tonnage for Existing Mines*	Number of Haul Trips for Existing Mines†	Number of New Mines	Number of Haul Trips for New Mines‡
North	528,449	21,138	18	221,298
East	0	0	2	22,240
South	181,185	7,247	6	73,967
Total	**709,634**	**28,385**	**26**	**317,505**

* Ore tonnage for existing mines (from personal communication, Spiering 2010a): Arizona 1 (180,671), Kanab North (92,834), Pinenut (254,944), and Canyon (181,185). Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 to account for this discrepancy.

† Based on 25 tons per haul trip.

‡ Based on 11,120 haul trips needed per average mine.

Reasonably Foreseeable Development under Alternative A—Miles of Power Lines

The existing and future proposed mines within the proposed withdrawal area probably would obtain all power from off-site; construction of power lines is a necessary surface disturbance for mine development. Power lines typically would be constructed using 40-foot wooden poles, with a 300-foot span between poles and a 12-foot-wide access road (Denison 2010). For the purposes of the RFD scenarios, power lines are assumed to approximately parallel haul roads and to not require construction of a separate access road. The estimates are shown in Table B-13.

- Assumption: Power lines will follow haul roads and will be the same length as the new roads.

Reasonably Foreseeable Development under Alternative A—Acreage of Surface Disturbance

Acreage disturbed includes the footprint of the mines themselves and the acreage disturbed by new roads, new power lines, and exploration activities. Estimates of the acreage disturbed by each mine footprint vary from 3 to 4 acres per mine (Wenrich 2009) to approximately 15 to 20 acres per mine (personal communication, Spiering 2010d) to more than 40 acres per mine (Denison 2010). It is important to note, with respect to the high end of this range, that the proposed mines would actually exploit multiple breccia pipes (EZ-1, EZ-2, What) from a single mine footprint and, as such, have greater surface disturbance. For the purposes of this analysis, an estimate of 20 acres of surface disturbance per mine is assumed. For roads, a width of 14 feet has been used, for a disturbance of 1.7 acres per mile (Denison 2010). For power lines, as there would be no separate access road, surface disturbance is assumed to be 10% of road disturbance, to account for the minimal permanent surface disturbance around poles and the temporary surface disturbance during construction. For exploratory activities, as shown in Table B-8, an estimate of 1.1 acres per exploration project has been used. Total acreage of disturbance is summarized in Table B-14 (rounded to the nearest acre).

Table B-13. Alternative A—No Withdrawal, Estimated Miles of New Power Lines (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Mines*	New Miles of Power Lines
North	18	16.4
East	2	2.4
South	6	3.6
Total	**26**	**22.4**

* Excludes existing mines (Pinenut, Kanab North, Arizona 1, and Canyon).

Table B-14. Alternative A—No Withdrawal, Estimated Surface Disturbance (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Road	New Miles of Power Lines	Number of Exploration Projects	Mine* Temporary Surface Disturbance (acres)	Road† Temporary Surface Disturbance (acres)	Power Lines‡ Temporary Surface Disturbance (acres)	Exploration§ Temporary Surface Disturbance (acres)
North	18	16.4	16.4	504	360	28	3	554
East	2	2.4	2.4	56	40	4	1	62
South	6	3.6	3.6	168	120	6	1	185
Total	**26**	**22.4**	**22.4**	**728**	**520**	**38**	**5**	**801**
Approximate Duration of Disturbance¶					**5–7 Years**	**5–7 Years**	**5–7 Years**	**1 Month**

* Assumes 20-acre footprint per mine.

† Assumes 14-foot width, for a disturbance of 1.7 acres per mile (Denison 2010).

‡ Assumes disturbance of 0.17 acre per mile from poles (10% of road disturbance).

§ Assumes disturbance of 1.1 acres per exploration project (BLM 1990:Table III-6).

- Assumption: There will be no additional surface disturbance from mines with approved plans of operation.
- Assumption: The surface disturbance for new mines will be 20 acres.
- Assumption: The surface disturbance for exploration activities will be 1.1 acres per exploration project.
- Assumption: The surface disturbance for haul roads will be 1.7 acres per mile, based on a road width of 14 feet.
- Assumption: The surface disturbance for power lines will be 0.17 acre per mile, which is 10% of road disturbance in order to account for temporary construction disturbance and permanent pole footprints.

Reasonably Foreseeable Development under Alternative A—Mine Water Use

Based on the existing mines in the area, each mine would likely have a deep production well to withdraw operational water from the Redwall Aquifer. Water use by mines for dust control, equipment washdown, underground drilling, and sanitation is estimated to average a continual 5 gallons per minute (gpm) over the 4-year operating life of the mine. Water is typically trucked in for any exploration activities, and it is assumed that reclamation will not require active watering after initial establishment of vegetation. Over the 4-year life span of a mine (development and production), this equals 10,512,000 gallons, or 32.3 acre-feet. Total water use volume and averaged water use rate are summarized in Table B-15. Table B-16 summarizes the activity associated with Alternative A.

Table B-15. Alternative A—No Withdrawal, Estimated Water Use (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Mines	Total Combined Water Use Volume for All Mines (million gallons)*	Total Combined Water Use Volume for All Mines (acre-feet)*	Approximate Rate of Water Use for All Mines (gpm)†
North	21	221	678	21
East	2	21	65	2
South	7	74	226	7
Total	**30**	**316**	**969**	**30**

* Based on mine use of 5 gpm over 4 years, for 10,512,000 gallons or 32.3 acre-feet per mine.

† Combined water use from all mines evenly spaced over the 20-year time frame.

- Assumption: There will be one well per mine.
- Assumption: Mines will use an estimated average of 5 gpm of water, which includes 2 gpm for sanitation and underground drilling and 3 gpm for dust suppression.
- Assumption: Water use will be limited to development and production periods (4 years), yielding a total water use per mine of 10,512,000 gallons.

Summary of Activity Associated with Alternative A—No Withdrawal (20-Year Time Frame)

Table B-16. Summary of Activity Associated with Alternative A—No Withdrawal (20-Year Time Frame)

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	21	2	7
Number of Exploration Projects	504	56	168
Miles of New Road	16.4	2.4	3.6
Number of Haul Trips	221,298	22,240	73,967
Miles of New Power Lines	16.4	2.4	3.6
Acreage of New Mine Footprint (5- to 7-year duration)	360	40	120
Acreage of New Roads (5- to 7-year duration)	28	4	6
Acreage of New Power Lines (5- to 7-year duration)	3	1	1
Acreage of Exploration (1-month duration)	554	62	185
Total Acreage Disturbed	945	107	312
Combined Water Use Volume for All Mines (million gallons)	221	21	74
Averaged Rate of Water Use from All Mines (gpm)	21	2	7

B.8.2 Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

The proposed withdrawal area currently contains approximately 3,350 mining claims (as of August 2011) that predate the Secretary's publication of the Notice of Proposed Withdrawal, subject to valid existing rights, on July 21, 2009. Mineral development could still occur under the Proposed Action, Alternative B. However, neither the BLM nor the Forest Service would allow new mines to be developed unless and until a mineral examination determined that the mining claims involved contained a discovery and were held by valid existing rights.Determining the validity of a mining claim is a complex and time-consuming legal, geological, and economic evaluation that is done on a claim-by-claim basis. Discovery can occur before or after location of a mining claim, but in any case discovery is based on the actual physical exposure of the mineral deposit within the claim boundaries. For the locatable minerals associated with breccia pipe deposits, unless erosion has exposed mineralization in a canyon, this would probably require exploratory drilling and sampling. The discovery would need to have taken place as of the date of segregation, July 21, 2009, and have been maintained until the time of the mineral examination. None of the assumptions in this analysis, even if referring to specific breccia pipes, should be construed as a determination or indication that certain mining claims may contain a discovery.

Future Locatable Minerals Activity

As with Alternative A, the number of potential future mines can be grouped into five categories, similar to those shown in Table B-1:

- Mines that are currently operating under approved plans of operation,
- Mines that may be developed from known mineralized breccia pipes with reliable estimated uranium resources,
- Mines that may be developed from known mineralized breccia pipes where uranium resources have yet to be estimated,
- Mines that may be developed from known breccia pipes for which the level of mineralization has yet to be determined, and
- Mines that may be developed from breccia pipes that are currently undiscovered.

Currently Approved Mines

As previously described, three mines within the proposed withdrawal area (Pinenut, Kanab North, and Canyon) were approved in the late 1980s, are operating under the interim management plans contained in their approved mining plans of operation, and are not currently producing uranium ore. An additional mine, Arizona 1, was developed, but no ore was removed until late 2009. Pinenut, Kanab North, and Arizona 1 are located within the North Parcel, while Canyon is located within the South Parcel. For the purposes of this analysis, it is assumed that all four of these mines will continue operations.

- ➢ Assumption: All four mines with approved plans of operation will resume production under Alternative B.

Known Mineralized Breccia Pipes with Estimated Uranium Resources

A further 26 confirmed breccia pipes within the proposed withdrawal area are known to have some level of mineralization (see Table B-3). Of these, seven have been confirmed to have uranium resources, and those uranium resources have been estimated. For the purposes of the RFD scenario, it is assumed that these breccia pipes have valid existing rights and would be mined. All seven breccia pipes with estimated uranium resources are located within the North Parcel.

- ➢ Assumption: The seven breccia pipes with estimated uranium resources will be mined under Alternative B.

Known Mineralized Breccia Pipes with No Estimate of Uranium Resources

Uranium resources have not been calculated for the remaining 19 confirmed mineralized breccia pipes (see Table B-3). Under Alternative A, it was assumed that 10% of these breccia pipes might contain uranium ore bodies and ultimately could be mined. While this is still true under Alternative B, it is assumed that if uranium resources have not yet been estimated, then it is likely that insufficient information is available to show discovery and be considered a valid existing right under the withdrawal. Therefore, for any mineralized breccia pipes lacking an estimate of uranium resources, it is assumed they would not be developed under this alternative.

- ➢ Assumption: If no estimate of uranium resources has been made, it is unlikely that sufficient information exists to show a valid existing right. None of the 19 confirmed mineralized breccia pipes without resource estimates will be developed.

Known Breccia Pipes with Undetermined Mineralization

As with the known mineralized breccia pipes without estimates of uranium resources, it is assumed that the remaining 10 confirmed breccia pipes within the proposed withdrawal area whose level of mineralization has yet to be determined (see Table B-3) would lack the necessary discovery to establish valid existing rights; it is therefore assumed these breccia pipes would not be mined under Alternative B.

- Assumption: If no estimate of uranium resources has been made, it is unlikely that sufficient information exists to show a valid existing right. None of the 10 confirmed breccia pipes with undetermined mineralization will be developed.

Undiscovered Uranium Resources

Under Alternative B, it is assumed that none of the estimated undiscovered uranium endowment would be mined, as no further exploration would take place to discover these deposits or to determine the extent of any potential uranium ore bodies.

- Assumption: If no estimate of uranium resources has been made, it is unlikely that sufficient information exists to show a valid existing right. No undiscovered uranium endowment would be mined.

Reasonably Foreseeable Development under Alternative B—Number of Mines

The estimates presented above are summarized in Table B-17. Under Alternative B, reasonably foreseeable uranium mining activity could occur only at the four existing mines and at the seven mines that have confirmed mineralized breccia pipes with estimated uranium resources. Mines would not develop from any of the other confirmed breccia pipes, nor would mines develop from further exploration and development of the undiscovered uranium endowment within the proposed withdrawal area.
As shown in Table B-17, under Alternative B, the limiting factor for the number of mines that could be developed is the number of claims for which valid existing rights could presumably exist. The RFD scenario for the number of plans of operation that might be submitted to the BLM and Kaibab National Forest, in addition to those plans of operation already approved, under Alternative B is 11: 10 in the North Parcel, none in the East Parcel, and one in the South Parcel.

Table B-17. Alternative B—Proposed Withdrawal, Estimated Number of Mines (20-Year Time Frame)

	North Parcel	East Parcel	South Parcel	Total
A) Existing Mines	3	0	1	**4**
B) Mines Associated with Mineralized Breccia Pipes with Estimated Uranium Resources	7	0	0	**7**
C) Mines Associated with Mineralized Breccia Pipes with No Estimated Uranium Resources	0	0	0	**0**
D) Mines Associated with Breccia Pipes with Undetermined Mineralization	0	0	0	**0**
E) Number of Mines Anticipated to Extract Estimated Undiscovered Uranium Resources	0	0	0	**0**
F) Reasonably Foreseeable Development under Alternative B	10	0	1	**11**

A) Pinenut, Kanab North, Arizona 1, and Canyon.
B) Assumes that all mineralized breccia pipes with estimated uranium resources will be developed.
C) Assumes that insufficient information is available to show valid existing rights.
D) Assumes that insufficient information is available to show valid existing rights.
E) Assumes that insufficient information is available to show valid existing rights.
F) RFD scenario is assumed to be the sum of existing mines and likely mines associated with known and unknown breccia pipes [A + B + C + D + E].

Reasonably Foreseeable Development under Alternative B—Exploration Activities

As described above, it is assumed that only existing mines and the breccia pipes with already identified deposits would be likely to be able to proceed to mine development and that further exploration on other claims would not be allowed under a mineral withdrawal. Therefore, exploration activities would likely cease under Alternative B.

However, it is possible that in certain areas, a minor level of exploration might continue. In several cases, multiple breccia pipes have been shown to occur in close proximity (e.g., Hack 1, 2, and 3; EZ-1, EZ-2, and What). Exploration for additional breccia pipes could take place within the boundaries of mining claims already held by valid existing rights. For the purposes of the RFD scenario, it is assumed that no more than 11 such exploration projects might be submitted to the BLM and Kaibab National Forest over the 20-year time frame (Table B-18).

Table B-18. Alternative B—Proposed Withdrawal, Estimated Exploratory Activity (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Mines	Number of Exploration Projects	Number of Drill Holes*
North	10	10	50
East	0	0	0
South	1	1	5
Total	**11**	**11**	**55**

* Based on average of five drill holes per exploration project.

Reasonably Foreseeable Development under Alternative B—Miles of New Roads and Number of Haul Trips

No additional road-building activity would take place to support the four existing mines. However, roads would likely need to be built for the seven confirmed breccia pipes with estimated uranium resources. The analysis follows an approach similar to what was used under Alternative A to estimate the necessary miles of new roads. The estimates are shown in Table B-19.

As previously described, a total of 11,120 haul trips would be required for the average mine. The expected number of haul trips under Alternative B is summarized in Table B-20.

Table B-19. Alternative B—Proposed Withdrawal, Estimated Miles of New Roads (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Road
North	7	6.4
East	0	0
South	0	0
Total	**7**	**6.4**

Reasonably Foreseeable Development under Alternative B—Miles of Power Lines

No additional power lines would be built for the four existing mines. However, power lines would likely need to be built for the seven confirmed breccia pipes with estimated uranium resources. The analysis follows an approach similar to what was used under Alternative A to estimate the necessary miles of new power lines. The estimates are shown in Table B-21.

Table B-20. Alternative B—Proposed Withdrawal, Estimated Number of Haul Trips (20-Year Time Frame)

Proposed Withdrawal Parcel	Ore Tonnage for Existing Mines*	Number of Haul Trips for Existing Mines†	Number of New Mines	Number of Haul Trips for New Mines‡
North	528,449	21,138	7	98,978
East	0	0	0	0
South	181,185	7,247	0	7,247
Total	**709,634**	**28,385**	**7**	**106,225**

* Ore tonnage for existing mines (from personal communication, Spiering 2010a): Arizona 1 (180,671), Kanab North (92,834), Pinenut (254,944), and Canyon (181,185). Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 to account for this discrepancy.
† Based on 25 tons per haul trip.
‡ Based on 11,120 haul trips needed per average mine.

Table B-21. Alternative B—Proposed Withdrawal, Estimated Miles of New Power Lines (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Power Lines
North	7	6.4
East	0	0
South	0	0
Total	**7**	**6.4**

Reasonably Foreseeable Development under Alternative B—Acreage of Surface Disturbance

Acreage disturbed would include the footprint of the mines themselves and the acreage disturbed by new roads, new power lines, and exploration activities. As with Alternative A, mine footprints are assumed to be 20 acres, new roads are assumed to have a disturbance of 1.7 acres per mile, new power lines are assumed to have a disturbance of 0.17 acre per mile, and exploratory activities are assumed to have a disturbance of 1.1 acres per project. Total acreage of disturbance is summarized in Table B-22 (rounded to the nearest acre).

Table B-22. Alternative B—Proposed Withdrawal, Estimated Surface Disturbance (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Road	New Miles of Power Lines	Number of Exploration Projects	Mine* Temporary Surface Disturbance (acres)	Road† Temporary Surface Disturbance (acres)	Power Lines‡ Temporary Surface Disturbance (acres)	Exploration§ Temporary Surface Disturbance (acres)
North	7	6.4	6.4	10	140	11	1	11
East	0	0	0	0	0	0	0	0
South	0	0	0	1	0	0	0	1
Total	**7**	**6.4**	**6.4**	**11**	**140**	**11**	**1**	**12**
Approximate Duration of Activity					**5–7 Years**	**5–7 Years**	**5–7 Years**	**1 Month**

* Assumes 20-acre footprint per mine.
† Assumes 14-foot width, for a disturbance of 1.7 acres per mile (Denison 2010).
‡ Assumes disturbance of 0.17 acre per mile from poles (10% of road disturbance).
§ Assumes disturbance of 1.1 acres per exploration project (BLM 1990:Table III-6).

Reasonably Foreseeable Development under Alternative B—Mine Water Use

Water use is estimated to average a continual 5 gpm over the 4-year operating life of the mine. Over the 4-year life span of a mine (development and production), this totals 10,512,000 gallons, or 32.3 acre-feet. Total water use volume and average water use rate are summarized in Table B-23. Table B-24 summarizes the impacts under Alternative B.

Table B-23. Alternative B—Proposed Withdrawal Estimated Water Use (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Mines	Total Combined Water Use Volume for All Mines (million gallons)*	Total Combined Water Use Volume for All Mines (acre-feet)*	Approximate Water Use Rate for All Mines (gpm)†
North	10	105	323	10
East	0	0	0	0
South	1	11	32	1
Total	**11**	**116**	**355**	**11**

* Based on mine use of 5 gpm over 4 years, for 10,512,000 gallons or 32.3 acre-feet per mine.
† Combined water use from all mines, evenly spaced over the 20-year time frame.

Summary of Activity Associated with Alternative B—Proposed Withdrawal (20-Year Time Frame)

Table B-24. Summary of Activity Associated with Alternative B—Proposed Withdrawal (20-Year Time Frame)

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	10	0	1
Number of Exploration Projects	10	0	1
Miles of New Road	6.4	0	0
Number of Haul Trips	98,978	0	7,247
Miles of New Power Lines	6.4	0	0
Acreage of New Mine Footprint (5- to 7-year disturbance)	140	0	0
Acreage of New Roads (5- to 7-year disturbance)	11	0	0
Acreage of New Power Lines (5- to 7-year disturbance)	1	0	0
Acreage of Exploration (1-month disturbance)	11	0	1
Total Disturbed Acreage	163	0	1
Combined Water Use Volume for All Mines (million gallons)	105	0	11
Average Rate of Water Use from All Mines (gpm)	10	0	1

B.8.3 Alternative C: Partial Withdrawal (~650,000 Acres)

The potential withdrawal under Alternative C is similar to that described for Alternative B, except that it would apply to a smaller area: 648,805 acres of federal lands, compared with approximately 1 million acres under Alternative B. Mining and exploration in areas outside the withdrawal boundary would take place as usual.

Future Locatable Mineral Exploration and Development

As with Alternatives A and B, the number of potential future mines can be grouped into five categories, similar to those shown in Table B-1:

- Mines that are currently operating under approved plans of operation,
- Mines that may be developed from known mineralized breccia pipes with reliable estimated uranium resources,
- Mines that may be developed from known mineralized breccia pipes where uranium resources have yet to be estimated,
- Mines that may be developed from known breccia pipes for which the level of mineralization has yet to be determined, and
- Mines that may be developed from breccia pipes that are currently undiscovered.

Currently Approved Mines

As previously described, three mines within the proposed withdrawal area (Pinenut, Kanab North, and Canyon) were approved in the late 1980s, are operating under the interim management plans contained in their approved mining plans of operation, and are not currently producing uranium ore. An additional mine, Arizona 1, was developed, but no ore was removed until late 2009. Pinenut, Kanab North, and Arizona 1 are located within the North Parcel and are within the partial withdrawal area proposed under Alternative C. Canyon is located within the South Parcel and is not within the partial withdrawal area proposed under Alternative C. For the purposes of the analysis of Alternative C, it is assumed that all four of these mines would continue operations.

- ➢ Assumption: All four mines with approved plans of operation will resume production under Alternative C.

Known Mineralized Breccia Pipes with Estimated Uranium Resources

A further 26 confirmed breccia pipes within the proposed withdrawal area are known to have some level of mineralization (see Table B-3). Of these, seven have been confirmed to have uranium resources, and those uranium resources have been estimated. All seven breccia pipes are located within the North Parcel and are within the partial withdrawal area proposed under Alternative C. For the purposes of the RFD scenario, it is assumed that under Alternative C, these breccia pipes are likely to have valid existing rights and would be mined.

- ➢ Assumption: The seven breccia pipes with estimated uranium resources will be mined under Alternative C.

Known Mineralized Breccia Pipes with No Estimate of Uranium Resources

Uranium resources have not been calculated for the remaining 19 confirmed mineralized breccia pipes (see Table B-3); only 14 of these confirmed mineralized breccia pipes are located within the partial withdrawal area proposed under Alternative C.

Under Alternative A, it was assumed that 15% of these breccia pipes might contain uranium ore bodies and ultimately be mined. For the 14 mineralized breccia pipes located within the partial withdrawal area proposed under Alternative C, it is assumed that if uranium resources have not yet been estimated, then insufficient information is available to show discovery and be considered a valid existing right. Therefore, under Alternative C, the mineralized breccia pipes lacking an estimate of uranium resources are not assumed to have valid existing rights and are not likely to be mined.

However, under Alternative C, five of these mineralized breccia pipes are located outside the proposed partial withdrawal area and could be subject to additional exploration and possibly mine development. It is estimated that because an estimated 15% of mineralized breccia pipes might be economically mined, one of these breccia pipes might yield a viable ore body on the South Parcel.

- Assumption: An additional 14 breccia pipes are confirmed to be mineralized and are located within the partial withdrawal area. If no estimate of uranium resources has been made, it is unlikely that sufficient information exists to show a valid existing right. None of the 14 confirmed mineralized breccia pipes without resource estimates within the proposed partial withdrawal area under Alternative C will be developed.
- Assumption: An additional five breccia pipes confirmed to be mineralized are located outside the proposed partial withdrawal area under Alternative C, and these can be developed.
- Assumption: An estimated 15% of mineralized breccia pipes contain minable amounts of uranium, yielding a total of one mine resulting from the five confirmed mineralized breccia pipes under Alternative C.

Known Breccia Pipes with Undetermined Mineralization

Of the remaining 10 confirmed breccia pipes with an undetermined extent of mineralization (see Table B-3), only four are within the partial withdrawal area proposed under Alternative C. For the four undetermined breccia pipes located within the partial withdrawal area proposed under Alternative C, it is assumed that if uranium resources have not yet been estimated, then insufficient information is likely available to show discovery and be considered a valid existing right. Therefore, under Alternative C, none of these breccia pipes are likely to be mined.

The six remaining breccia pipes are located outside the partial withdrawal area proposed under Alternative C and could potentially be mined; however, the probability of a given breccia pipe yielding a viable ore body is perhaps 1 in 100. Therefore, it is unlikely that any of these particular breccia pipes would be developed under Alternative C.

- Assumption: An additional four breccia pipes are confirmed within the Alternative C proposed partial withdrawal area, but it is not known whether they are mineralized or not. If no estimate of uranium resources has been made, it is unlikely that sufficient information exists to show a valid existing right. None of the four confirmed breccia pipes within the Alternative C proposed partial withdrawal area with undetermined mineralization will be developed.
- Assumption: An additional six breccia pipes of undetermined mineralization are located outside the Alternative C proposed partial withdrawal area, and these can be developed.
- Assumption: An estimated 1% of all breccia pipes contain minable amounts of uranium, yielding no mines resulting from the six confirmed breccia pipes under Alternative C.

Undiscovered Uranium Resources

In contrast to Alternative B, a portion of the undiscovered uranium resources could potentially be extracted from outside the Alternative C proposed partial withdrawal area. The amount of undiscovered uranium resources has been extrapolated based on the percentage of the entire proposed withdrawal area that will remain open to location and entry under the Mining Law under Alternative C, as shown in Table B-25.

Table B-25. Estimated Undiscovered Uranium Endowment Available under Alternative C

Proposed Withdrawal Parcel	Total Undiscovered Uranium Endowment (tons U_3O_8) in Entire Proposed Withdrawal Area*	Percentage of Proposed Withdrawal Area Not Withdrawn under Alternative C	Estimated Undiscovered Uranium Endowment (tons U_3O_8) Available under Alternative C	Estimated Number of Mines†
North	91,944	36%	33,100	3
East	22,257	34%	7,567	1
South	49,179	36%	17,704	2
Total	**163,380**		**58,371**	**6**

* USGS (2010:Chapter A, Table 8).

† Based on 15% of undiscovered uranium endowment and an average of 1,500 tons U_3O_8 per typical breccia pipe ore body.

- Assumption: An estimated 24,508 tons U_3O_8 is as yet undiscovered and minable within the entire proposed withdrawal area.
- Assumption: Only uranium endowment outside the Alternative C proposed partial withdrawal area would be mined. Based on the percentage of area not withdrawn under Alternative C, the undiscovered uranium endowment is 8,756 tons U_3O_8, yielding six mines.

Reasonably Foreseeable Development under Alternative C—Number of Mines

The estimates presented above are summarized in Table B-26. Under Alternative C, reasonably foreseeable uranium mining could occur from four existing mines and from confirmed mineralized breccia pipes with estimated uranium resources at seven mines. Mines would not develop from any of the other confirmed breccia pipes within the Alternative C proposed partial withdrawal area, nor would mines develop from further exploration and development of the undiscovered uranium endowment within the Alternative C proposed partial withdrawal area. However, of the five confirmed mineralized breccia pipes outside the Alternative C proposed partial withdrawal area, perhaps one would be mined on the South Parcel. In addition, a portion of the undiscovered uranium resources that are located outside the Alternative C proposed partial withdrawal area could be developed, resulting in an estimated six new mines.

As shown in Table B-26, the number of potential mines in Alternative C is less than the limitations of the industry to find, develop, and exploit ore bodies. As such, the RFD scenario for the number of plans of operation that could be submitted to BLM and the Forest Service under Alternative C is 18: 13 in the North Parcel, one in the East Parcel, and four in the South Parcel.

Reasonably Foreseeable Development under Alternative C—Exploration Activities

Under Alternative C, further exploration on mining claims with the proposed partial withdrawal area would not occur. For the most part, exploration activities would cease under Alternative C within the proposed partial withdrawal area. However, it is feasible that in certain areas, minor levels of exploration might continue. For the purposes of the RFD scenario, it is assumed that no more than 11 exploration projects might be submitted to the BLM and Kaibab National Forest over the 20-year time frame of the withdrawal.

Unlike under Alternative B, exploration could still continue outside the partial withdrawal area proposed under Alternative C, yielding an estimated seven new mines, as shown in Table B-27.

Table B-26. Alternative C—Partial Withdrawal, Estimated Number of Mines (20-Year Time Frame)

	North Parcel	East Parcel	South Parcel	Total
A) Existing Mines	3	0	1	**4**
B) Mines Associated with Mineralized Breccia Pipes with Estimated Uranium Resources	7	0	0	**7**
C) Mines Associated with Mineralized Breccia Pipes with No Estimated Uranium Resources	0	0	1	**1**
D) Mines Associated with Breccia Pipes with Undetermined Mineralization	0	0	0	**0**
E) Number of Mines Anticipated to Be Needed to Extract Estimated Undiscovered Uranium Resources	3	1	2	**6**
F) Reasonably Foreseeable Development under Alternative C	13	1	4	**18**

A) Pinenut, Kanab North, Arizona 1, and Canyon.

B) Assumes that all mineralized breccia pipes with estimated uranium resources will be developed.

C) Assumes that insufficient information is available to show valid existing rights for those within withdrawal area; assumes 15% of the five breccia pipes outside the withdrawal area might be mined.

D) Assumes that insufficient information is available to show valid existing rights for withdrawal area and that these are unlikely to be mined outside the withdrawal area.

E) Assumes that insufficient information is available to establish valid existing rights in the withdrawal area but that resources could be mined outside the withdrawal area, with the number of mines being based on 15% of the USGS (2010) undiscovered uranium endowment estimate and an average 1,500 tons U_3O_8 per mine.

F) RFD scenario is assumed to be the sum of existing mines and likely mines associated with known and unknown breccia pipes [A + B + C + D + E].

Table B-27. Alternative C—Partial Withdrawal, Estimated Exploratory Activity Needed to Support Uranium Production (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Exploration Projects within Proposed Withdrawal Area	Number of New Mines Outside Proposed Withdrawal Area	Number of Exploration Projects Outside Proposed Withdrawal Area*	Total Number of Exploration Projects	Number of Drill Holes†
North	10	3	84	94	470
East	0	1	28	28	140
South	1	3	84	85	425
Total	**11**	**7**	**196**	**207**	**1,035**

* Based on average of 28 exploration projects per ore body discovered.

† Based on average of five drill holes per exploration project.

Reasonably Foreseeable Development under Alternative C—Miles of New Roads and Number of Haul Trips

No additional road-building activity would take place to support the four existing mines. However, roads would likely need to be built for the new mines both inside and outside the Alternative C proposed partial withdrawal area. The analysis follows an approach similar to what was used under Alternative A to estimate the necessary miles of new roads. The estimates are shown in Table B-28.

As previously described, a total of 11,120 haul trips would be required for the average mine. The expected number of haul trips under Alternative C is summarized in Table B-29.

Table B-28. Alternative C—Partial Withdrawal, Estimated Miles of New Roads (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Road
North	10	9.1
East	1	1.2
South	3	1.8
Total	**14**	**12.1**

Table B-29. Alternative C—Partial Withdrawal, Estimated Number of Haul Trips (20-Year Time Frame)

Proposed Withdrawal Parcel	Ore Tonnage for Existing Mines*	Number of Haul Trips for Existing Mines†	Number of New Mines	Number of Haul Trips for New Mines‡
North	528,449	132,338	10	111,200
East	0	11,120	1	11,120
South	181,185	40,607	3	33,360
Total	**709,634**	**184,065**	**14**	**155,680**

* Ore tonnage for existing mines (from personal communication, Spiering 2010a): Arizona 1 (180,671), Kanab North (92,834), Pinenut (254,944), and Canyon (181,185). Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 to account for this discrepancy.

† Based on 25 tons per haul trip.

‡ Based on 11,120 haul trips needed per average mine tonnage.

Reasonably Foreseeable Development under Alternative C—Miles of Power Lines

No additional power lines would be built for the four existing mines. However, power lines would likely need to be built for the new mines both within and outside the Alternative C proposed partial withdrawal area. The analysis follows an approach similar to what was used under Alternative A to estimate the necessary miles of new power lines. The estimates are shown in Table B-30.

Table B-30. Alternative C—Partial Withdrawal, Estimated Miles of New Power Lines (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Power Lines
North	10	9.1
East	1	1.2
South	3	1.8
Total	**14**	**12.1**

Reasonably Foreseeable Development under Alternative C—Acreage of Surface Disturbance

Acreage disturbed could include the footprint of the mines themselves and the acreage disturbed by new roads, new power lines, and exploration activities. As with Alternative A, mine footprints are assumed to be 20 acres, new roads are assumed to have a disturbance of 1.7 acres per mile, new power lines are assumed to have a disturbance of 0.17 acre per mile, and exploratory activities are assumed to have a disturbance of 1.1 acres per project. Total acreage of disturbance is summarized in Table B-31 (rounded to the nearest acre).

Table B-31. Alternative C—Partial Withdrawal, Estimated Surface Disturbance (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Road	New Miles of Power Lines	Number of Exploration Projects	Mine* Temporary Surface Disturbance (acres)	Road† Temporary Surface Disturbance (acres)	Power lines‡ Temporary Surface Disturbance (acres)	Exploration§ Temporary Surface Disturbance (acres)
North	10	9.1	9.1	94	200	15	2	103
East	1	1.2	1.2	28	20	2	1	31
South	3	1.8	1.8	85	60	3	1	94
Total	**14**	**12.1**	**12.1**	**207**	**280**	**20**	**4**	**228**
Approximate Duration of Disturbance					**5–7 Years**	**5–7 Years**	**5–7 Years**	**1 Month**

* Assumes 20-acre footprint per mine.

† Assumes 14-foot width, for a disturbance of 1.7 acres per mile (Denison 2010).

‡ Assumes disturbance of 0.17 acre per mile from poles (10% of road disturbance).

§ Assumes disturbance of 1.1 acres per exploration project (BLM 1990:Table III-6).

Reasonably Foreseeable Development under Alternative C—Mine Water Use

Water use is estimated to average a continual 5 gpm over the 4-year operating life of the mine. Over the 4-year life span of a mine (development and production), this totals 10,512,000 gallons, or 32.3 acre-feet. Total water use volume and average water use rate are summarized in Table B-32. Table B-33 summarizes the impacts associated with Alternative C.

Table B-32. Alternative C—Partial Withdrawal, Estimated Water Use (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Mines	Total Combined Water Use Volume for All Mines (million gallons)*	Total Combined Water Use Volume for All Mines (acre-feet)*	Approximate Water Use Rate (gpm)†
North	13	137	420	13
East	1	11	32	1
South	4	42	129	4
Total	**18**	**190**	**581**	**18**

* Based on mine use of 5 gpm over 4 years, for 10,512,000 gallons or 32.3 acre-feet per mine.

† Combined water use from all mines, evenly spaced over the 20-year time frame, rounded.

Summary of Activity Associated with Alternative C—Partial Withdrawal (20-Year Time Frame)

Table B-33. Summary of Activity Associated with Alternative C—Partial Withdrawal (20-Year Time Frame)

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	13	1	4
Number of Exploration Projects	94	28	85
Miles of New Road	9.1	1.2	1.8
Number of Haul Trips	132,338	11,120	40,607
Miles of New Power Lines	9.1	1.2	1.8

Table B-33. Summary of Activity Associated with Alternative C—Partial Withdrawal (20-Year Time Frame), Continued

Activity	North Parcel	East Parcel	South Parcel
Acreage of New Mine Footprint (5- to 7-year duration)	200	20	60
Acreage of New Roads (5- to 7-year duration)	15	2	3
Acreage of New Power Lines (5- to 7-year duration)	2	1	1
Acreage of Exploration (1-month duration)	103	31	94
Total Disturbed Acreage	320	54	158
Combined Water Use All Mines (million gallons)	137	11	42
Average Rate of Water Use from All Mines (gpm)	13	1	4

B.8.4 Alternative D: Partial Withdrawal (~300,000 Acres)

The area to be withdrawn under Alternative D would apply to approximately 292,088 acres of federal lands. As with Alternative B, the Alternative D proposed partial withdrawal would occur for a period of 20 years; no new mining claims could be located within the Alternative D proposed partial withdrawal area, nor could further exploration or development occur on existing mining claims within the Alternative D proposed partial withdrawal area unless valid existing rights were first established. Mineral exploration and development on mining claims with valid existing rights would continue under the respective BLM or Forest Service surface management regulations. Mining and exploration in areas outside the Alternative D proposed partial withdrawal boundary would take place as usual.

Future Locatable Mineral Exploration and Development

The number of potential future mines can be grouped into five categories, similar to those shown in Table B-1:

- Mines that are currently operating under approved plans of operation,
- Mines that may be developed from known mineralized breccia pipes with reliable estimated uranium resources,
- Mines that may be developed from known mineralized breccia pipes where uranium resources have yet to be estimated,
- Mines that may be developed from known breccia pipes for which the level of mineralization has yet to be determined, and
- Mines that may be developed from breccia pipes that are currently undiscovered.

Currently Approved Mines

As previously described, three mines within the proposed withdrawal area (Pinenut, Kanab North, and Canyon) were approved in the late 1980s, are operating under the interim management plans in their approved mining plans of operation, are not currently producing uranium ore. An additional mine, Arizona 1, was developed, but no ore was removed until late 2009. Pinenut, Kanab North, and Arizona 1 are located within the North Parcel; Pinenut and Kanab North are located within the Alternative D proposed partial withdrawal area, but Arizona 1 is located outside the Alternative D proposed partial withdrawal area. The Canyon mine is located within the South Parcel but is not within the Alternative D proposed partial withdrawal area. For the purposes of analysis of Alternative D, it is assumed that all four of these mines would continue operations.

- Assumption: All four mines with approved plans of operation will resume production under Alternative D.

Known Mineralized Breccia Pipes with Estimated Uranium Resources

There are a further 26 confirmed breccia pipes within the proposed withdrawal area known to have some level of mineralization (see Table B-3). Of these, seven have been confirmed to have uranium resources, and those uranium resources have been estimated. All seven breccia pipes are located within the North Parcel. Six of these breccia pipes are outside the boundary of the Alternative D proposed partial withdrawal area; only the Rim breccia pipe lies within the Alternative D proposed partial withdrawal area. For the purposes of the RFD scenario, it is assumed that under Alternative D, all seven of these breccia pipes with confirmed uranium resources are likely to have valid existing rights and could be mined.

- Assumption: The seven breccia pipes with estimated uranium resources will be mined under Alternative D.

Known Mineralized Breccia Pipes with No Estimate of Uranium Resources

Uranium resources have not been calculated for the remaining 19 confirmed mineralized breccia pipes (see Table B-3); only two of these confirmed mineralized breccia pipes (Clearwater, Lost Calf) are located within the Alternative D proposed partial withdrawal area.

For the two mineralized breccia pipes located within the Alternative D proposed partial withdrawal area, it is assumed that if uranium resources have not yet been estimated, then insufficient information is likely available to establish valid existing rights. Therefore, mineralized breccia pipes that lack an estimate of uranium resources are presumed not to possess valid existing rights and to be unable to be mined.

However, under Alternative D, 17 of these mineralized breccia pipes are located outside the Alternative D proposed partial withdrawal area and could potentially be mined. It is estimated that perhaps three of these breccia pipes might yield a viable ore body (two on the North Parcel and one on the South Parcel).

- Assumption: An additional two breccia pipes are confirmed to be mineralized and are located within the Alternative D proposed partial withdrawal area. If no estimate of uranium resources has been made, it is unlikely that sufficient information exists to show a valid existing right. Neither of the two confirmed mineralized breccia pipes without resource estimates within the Alternative D proposed partial withdrawal area will be developed.
- Assumption: An additional 17 breccia pipes confirmed to be mineralized are located outside the Alternative D proposed partial withdrawal area, and these can be developed.
- Assumption: An estimated 15% of mineralized breccia pipes contain minable amounts of uranium, yielding a total of three mines resulting from the 17 confirmed mineralized breccia pipes under Alternative D.

Known Breccia Pipes with Undetermined Mineralization

Of the remaining 10 confirmed breccia pipes with an undetermined extent of mineralization (see Table B-3), only one is within the Alternative D proposed partial withdrawal area. For the one undetermined breccia pipe located within the partial withdrawal area proposed under Alternative D, it is assumed that if uranium resources have not yet been estimated, then insufficient information is available to show discovery and establish a valid existing right. Therefore, under Alternative D, this breccia pipe is not likely to be mined.

The nine remaining breccia pipes are located outside the Alternative D proposed partial withdrawal area and could potentially be mined; however, the probability of a given breccia pipe yielding a viable ore body is perhaps 1 in 100. Therefore, it is unlikely that any of these breccia pipes would be developed under Alternative D.

- Assumption: A single additional breccia pipe is confirmed within the Alternative D proposed partial withdrawal area, but it is not known whether it is mineralized or not. If no estimate of uranium resources has been made, it is unlikely that sufficient information exists to show a valid existing right. This confirmed breccia pipes with undetermined mineralization within the Alternative D proposed partial withdrawal area will not be developed.
- Assumption: An additional nine breccia pipes of undetermined mineralization are located outside the Alternative D proposed partial withdrawal area, and these can be developed.
- Assumption: An estimated 1% of all breccia pipes contain minable amounts of uranium, yielding no mines resulting from the nine confirmed breccia pipes under Alternative D.

Undiscovered Uranium Resources

In contrast to Alternative B, there are undiscovered uranium resources in the project area that are outside the Alternative D proposed partial withdrawal area, and these could potentially be developed under Alternative D. The amount of undiscovered uranium resources has been extrapolated based on the percentage of the Alternative D proposed partial withdrawal area that will remain open to location and entry under the Mining Law, as shown in Table B-34.

- Assumption: An estimated 24,508 tons U_3O_8 is as yet undiscovered and minable within the entire proposed withdrawal area.
- Assumption: Only uranium endowment outside the Alternative D proposed partial withdrawal area would be mined. Based on the percentage of area not withdrawn under Alternative D, the undiscovered uranium endowment is 17,506 tons U_3O_8, yielding 12 mines.

Table B-34. Estimated Undiscovered Uranium Endowment Available under Alternative D

Proposed Withdrawal Parcel	Total Undiscovered Uranium Endowment (tons U_3O_8) in Entire Proposed Withdrawal Area*	Percentage of Proposed Withdrawal Area Not Withdrawn under Alternative D	Estimated Undiscovered Uranium Endowment (tons U_3O_8) Available under Alternative D	Estimated Number of Mines†
North	91,944	81%	74,475	8
East	22,257	61%	13,577	1
South	49,179	59%	29,016	3
Total	**163,380**		**117,068**	**12**

* USGS (2010:Chapter A, Table 8).

† Based on 15% of undiscovered uranium endowment and an average of 1,500 tons U_3O_8 per typical breccia pipe ore body, rounded.

Reasonably Foreseeable Development under Alternative D—Number of Mines

The estimates presented above are summarized in Table B-35. Under Alternative D, reasonably foreseeable uranium mining would occur at the four existing mines and at the seven mines that have confirmed mineralized breccia pipes with estimated uranium resources. Mines would not develop from any of the other confirmed breccia pipes within the Alternative D proposed partial withdrawal area, nor would mines develop from further exploration and development of the undiscovered uranium endowment within the Alternative D proposed partial withdrawal area. However, of the 17 confirmed mineralized breccia pipes outside the proposed partial withdrawal area, perhaps three could be mined on the North and South parcels. In addition, a portion of the undiscovered uranium resources that are located outside the Alternative D proposed partial withdrawal area could still be developed, resulting in an estimated 12 new mines.

Table B-35. Alternative D—Partial Withdrawal, Estimated Number of Mines (20-Year Time Frame)

	North Parcel	East Parcel	South Parcel	Total
A) Existing Mines	3	0	1	**4**
B) Mines Associated with Mineralized Breccia Pipes with Estimated Uranium Resources	7	0	0	**7**
C) Mines Associated with Mineralized Breccia Pipes with No Estimated Uranium Resources	2	0	1	**3**
D) Mines Associated with Breccia Pipes with Undetermined Mineralization	0	0	0	**0**
E) Number of Mines Anticipated to Extract Estimated Undiscovered Uranium Resources	8	1	3	**12**
F) Reasonably Foreseeable Development under Alternative D	20	1	5	**26**

A) Pinenut, Kanab North, Arizona 1, and Canyon.

B) Assumes that all mineralized breccia pipes with estimated uranium resources could be developed.

C) Assumes that insufficient information is available to establish valid existing rights for those deposits within withdrawal area; assumes that 15% of the 17 breccia pipes outside the withdrawal area might be mined.

D) Assumes that insufficient information is available to show valid existing rights for withdrawal area and that these resources are unlikely to be mined outside the withdrawal area.

E) Assumes that insufficient information is available to show valid existing rights for withdrawal area but that these resources could be mined outside the withdrawal area, with the number of mines based on 15% of the USGS (2010) undiscovered uranium endowment estimate and an average 1,500 tons U_3O_8 per mine.

F) RFD scenario is assumed to be the sum of existing mines and likely mines associated with known and unknown breccia pipes [A + B + C + D + E].

The number of potential mines in Alternative D is less than the limitations of the industry to find, develop, and exploit ore bodies. As such, the RFD scenario for the number of plans of operation that might be submitted to the BLM and Kaibab National Forest under Alternative D is 26 mines: 20 in the North Parcel, one in the East Parcel, and five in the South Parcel.

Reasonably Foreseeable Development under Alternative D—Exploration Activities

Exploration on existing mining claims within the Alternative D proposed partial withdrawal area for the most part would cease. However, it is possible that in certain areas, minor levels of exploration might continue. It is assumed that no more than 11 such exploration projects might be submitted to the BLM and Kaibab National Forest over the 20-year time frame of the Alternative D proposed partial withdrawal area.

Exploration could still continue outside the Alternative D proposed partial withdrawal area and could yield an estimated 15 new mines, as shown in Table B-36.

Reasonably Foreseeable Development under Alternative D—Miles of New Roads and Number of Haul Trips

No additional road-building activity would take place to support the four existing mines. However, roads would likely need to be built to service the new mines both inside and outside the Alternative D proposed partial withdrawal area. The analysis follows an approach similar to what was used under Alternative A to estimate the necessary miles of new road construction. The estimates are shown in Table B-37.

Table B-36. Alternative D—Partial Withdrawal, Estimated Exploratory Activity Needed to Support Uranium Production (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Exploration Projects within Withdrawal Area	Number of New Mines Outside Withdrawal Area	Number of Exploration Projects Outside Withdrawal Area*	Total Number of Exploration Projects	Number of Drill Holes†
North	10	10	280	290	1,450
East	0	1	28	28	140
South	1	4	112	113	565
Total	**11**	**15**	**420**	**431**	**2,155**

* Based on average of 28 exploration projects per ore body discovered.

† Based on average of five drill holes per exploration project.

Table B-37. Alternative D—Partial Withdrawal, Estimated Miles of New Roads (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Road
North	17	15.5
East	1	1.2
South	4	2.4
Total	**22**	**19.1**

As previously described, a total of 11,120 haul trips would be required for the average mine. The expected number of ore haul trips under Alternative D is summarized in Table B-38.

Table B-38. Alternative D—Partial Withdrawal, Estimated Number of Haul Trips (20-Year Time Frame)

Proposed Withdrawal Parcel	Ore Tonnage for Existing Mines*	Number of Haul Trips for Existing Mines†	Number of New Mines	Number of Haul Trips for New Mines‡
North	528,449	21,138	17	210,178
East	0	0	1	11,120
South	181,185	7,247	4	51,727
Total	**709,634**	**28,385**	**22**	**273,025**

* Ore tonnage for existing mines (from personal communication, Spiering 2010a): Arizona 1 (180,671), Kanab North (92,834), Pinenut (254,944), and Canyon (181,185). Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 to account for this discrepancy.

† Based on 25 tons per haul trip.

‡ Based on 11,120 haul trips needed per average mine.

Reasonably Foreseeable Development under Alternative D—Miles of Power Lines

No additional power lines would be built for the four existing mines. However, power lines would likely need to be built for the new mines both within and outside the proposed partial withdrawal area.
The analysis follows an approach similar to what was used under Alternative A to estimate the necessary miles of new power lines. The estimates are shown in Table B-39.

Table B-39. Alternative D—Partial Withdrawal, Estimated Miles of New Power Lines (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Power Lines
North	17	15.5
East	1	1.2
South	4	2.4
Total	**22**	**19.1**

Reasonably Foreseeable Development under Alternative D—Acreage of Surface Disturbance

Acreage disturbed could include the footprint of the mines themselves and the acreage disturbed by new roads, new power lines, and exploration activities. Mine footprints are assumed to be 20 acres, new roads are assumed to have a disturbance of 1.7 acres per mile, new power lines are assumed to have a disturbance of 0.17 acre per mile, and exploratory activities are assumed to have a disturbance of 1.1 acres per project. Total acreage of disturbance is summarized in Table B-40 (rounded to the nearest acre).

Table B-40. Alternative D—Partial Withdrawal, Estimated Surface Disturbance (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of New Mines	New Miles of Road	New Miles of Power Lines	Number of Exploration Projects	Mine* Temporary Surface Disturbance (acres)	Road† Temporary Surface Disturbance (acres)	Power Lines‡ Temporary Surface Disturbance (acres)	Exploration§ Temporary Surface Disturbance (acres)
North	17	15.5	15.5	290	340	26	3	319
East	1	1.2	1.2	28	20	2	1	31
South	4	2.4	2.4	113	80	4	1	124
Total	**22**	**19.1**	**19.1**	**431**	**440**	**32**	**5**	**474**
Approximate Duration of Disturbance					**5–7 Years**	**5–7 Years**	**5–7 Years**	**1 Month**

* Assumes 20-acre footprint per mine.

† Assumes 14-foot width, for a disturbance of 1.7 acres per mile (Denison 2010).

‡ Assumes disturbance of 0.17 acre per mile from poles (10% of road disturbance).

§ Assumes disturbance of 1.1 acres per exploration project (BLM 1990:Table III-6).

Reasonably Foreseeable Development under Alternative D—Mine Water Use

Water use is estimated to average a continual 5 gpm over the 4-year operating life of the mine. Mine water use is estimated to be no more than 5 gpm. Over the 4-year operating life span of a mine (development and production), this totals 10,512,000 gallons, or 32.3 acre-feet. Total water use and average water use are summarized in Table B-41. Table B-42 summarizes impacts associated with Alternative D.

Table B-41. Alternative D—Partial Withdrawal Estimated Water Use (20-Year Time Frame)

Proposed Withdrawal Parcel	Number of Mines	Total Combined Water Use Volume for All Mines (million gallons)*	Total Combined Water Use Volume for All Mines (acre-feet)*	Approximate Water Use Rate (gpm)†
North	20	210	646	20
East	1	11	32	1
South	5	53	162	5
Total	**26**	**274**	**840**	**26**

* Based on mine use of 5 gpm over 4 years, for 10,512,000 gallons or 32.3 acre-feet per mine.

† Combined water use from all mines, evenly spaced over 20-year time span, rounded.

Summary of Activity Associated with Alternative D—Partial Withdrawal (20-Year Time Frame)

Table B-42. Summary of Activity Associated with Alternative D—Partial Withdrawal (20-Year Time Frame)

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	20	1	5
Number of Exploration Projects	290	28	113
Miles of New Road	15.5	1.2	2.4
Number of Haul Trips	210,178	11,120	51,727
Miles of New Power Lines	15.5	1.2	2.4
Acreage of New Mine Footprint (5- to 7-year duration)	340	20	80
Acreage of New Roads (5- to 7-year duration)	26	2	4
Acreage of New Power Lines (5- to 7-year duration)	3	1	1
Acreage of Exploration (1-month duration)	319	31	124
Total Disturbed Acreage	688	54	209
Combined Water Use Volume for All Mines (million gallons)	210	11	53
Average Rate of Water Use for All Mines (gpm)	20	1	5

B.9 SUMMARY

This section provides a summary of the RFD scenario for each alternative (Table B-43), as well as a summary of the assumptions used to develop the analysis (Table B-44).

Table B-43. Reasonably Foreseeable Future Mineral Exploration and Development by Alternative (20-Year Time Frame)

Activity	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 acres)	Alternative D Partial Withdrawal 20 Years (~300,000 acres)
Predicted exploration projects				
North Parcel	504	10	94	290
East Parcel	56	0	28	28
South Parcel	168	1	85	113
Subtotal	*728*	*11*	*207*	*431*

Table B-43. Reasonably Foreseeable Future Mineral Exploration and Development by Alternative (20-Year Time Frame), Continued

Activity	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Proposed Action 20 Years (~1 Million Acres Withdrawn)	Alternative C Partial Withdrawal 20 Years (~650,000 acres)	Alternative D Partial Withdrawal 20 Years (~300,000 acres)
Acres disturbed for exploration				
North Parcel	554	11	103	319
East Parcel	62	0	31	31
South Parcel	185	1	94	124
Subtotal	*801*	*12*	*228*	*474*
Predicted mining projects				
North Parcel	21	10	13	20
East Parcel	2	0	1	1
South Parcel	7	1	4	5
Subtotal	*30*	*11*	*18*	*26*
Acres disturbed for mining				
North Parcel	360	140	200	340
East Parcel	40	0	20	20
South Parcel	120	0	60	80
Subtotal	*520*	*140*	*280*	*440*
Number of ore haul trips required				
North Parcel	221,298	98,978	132,338	210,178
East Parcel	22,240	0	11,120	11,120
South Parcel	73,967	7,247	40,607	51,727
Subtotal	*317,505*	*106,225*	*184,065*	*273,025*
Miles of new power lines				
North Parcel	16.4	6.4	9.1	15.5
East Parcel	2.4	0	1.2	1.2
South Parcel	3.6	0	1.8	2.4
Subtotal	*22.4*	*6.4*	*12.1*	*19.1*
Miles of new roads for mine access				
North Parcel	16.4	6.4	9.1	15.5
East Parcel	2.4	0	1.2	1.2
South Parcel	3.6	0	1.8	2.4
Subtotal	*22.4*	*6.4*	*12.1*	*19.1*
Total acres disturbed for exploration and mining over 20-year time frame				
North Parcel	945	163	320	688
East Parcel	107	0	54	54
South Parcel	312	1	158	209
Subtotal	*1,364*	*164*	*532*	*951*
Water usage (million gallons) over 20-year time frame				
North Parcel	221	105	137	210
East Parcel	21	0	11	11
South Parcel	74	11	42	53
Subtotal	*316*	*116*	*190*	*274*

Table B-44. Assumptions Used to Develop Reasonably Foreseeable Development Scenarios

ID No.	Specific Assumption	Subcomponents of Assumption	Data Sources and Rationale
General RFD Framework Assumptions			
1	Uranium is the sole commodity of interest in the RFD	–	Withdrawal limited to locatable minerals only. There are no other significant deposits in area (strata-bound or otherwise) except for breccia pipes. Some ancillary commodities are recovered from breccia pipes but are not sufficient to drive mine development.
2	Time frame of analysis is 20 years	–	Limit of initial withdrawal period; furthermore, extrapolating conditions past 20 years is speculative.
3	Uranium commodity prices will remain at or above levels similar to today	–	As seen historically, large swings in commodity prices can drastically affect mine development, but accurate prediction of such swings is not likely. Assuming a floor for commodity prices allows extrapolation of current conditions, which allows a reasonable grounding in reality.
4	No major changes to the Mining Law are being considered	–	Any such changes would be speculative.
5	No major changes in royalty or tax systems are being considered	–	Any such changes would be speculative.
6	No major changes in environmental laws or regulations are being considered	–	Any such changes would be speculative.
7	Advances in technology are unlikely to change mine development with respect to breccia pipes	–	Technology is constantly improving, potentially allowing lower ore grades to be recovered. However, the breccia pipe deposits in northern Arizona are not of marginal grade. Rather, they contain higher ore grades than 85% of the uranium deposits worldwide. Incremental changes in technology are unlikely to affect breccia pipe mining over the near future.
General Mining Scenario			
8	Each mine will consist of a single breccia pipe	–	In two cases, a single mine footprint has or is planned to access multiple pipes, but in most cases a mine accesses only a single breccia pipe. In cases where multiple pipes are accessed (i.e., EZ1/EZ2/What), the footprint is larger than for a single pipe, which results in a similar surface disturbance per breccia pipe, compared with one mine accessing one breccia pipe.
9	Once planning/permitting starts, mines will proceed through development, production, and reclamation and will not require interim management	–	Interim management historically has been caused primarily by commodity prices. For the purposes of the RFD, commodity prices are assumed to remain at or above current levels (see ID 3). Other reasons for entering interim management are considered speculative.

Table B-44. Assumptions Used to Develop Reasonably Foreseeable Development Scenarios, Continued

ID No.	Specific Assumption	Subcomponents of Assumption	Data Sources and Rationale
Industrial Capacity to Mine Uranium			
10	Estimated number of mines industry can support over next 20 years is 37	Up to 6 mines could be concurrently in production at any one time	Based on the number of breccia pipes concurrently being mined in the 1980s, the number of breccia pipes currently in line for development, and similar assumptions used in ACERT (2009) report. Assumes no limitation in milling capacity; for the purposes fo analysis milling is assumed to occur at White Mesa Mill. However, other mills may also see changes in activity based on specific business relationships with mines.
11		Planning/permitting period of 2 years	Based on the expected time frame for NEPA compliance and Arizona permitting requirements (APP).
12		Development period of 1 year	Based on historical mine development periods.
13		Production period of 3 years	Based on historical mine production periods, expected volume or ore to be removed from a typical breccia pipe (278,000 tons), and haul capacity of 300 to 400 tons per day from the EZ1/EZ2 draft plan of operation.
14		Reclamation period of 1 year	Based on historical mine reclamation periods. Reclamation success is expected to take several seasons to occur.
Quantity of Uranium Available to Mine			
15	A typical breccia pipe contains 1,500 tons U_3O_8	–	Five breccia pipes in the proposed withdrawal area have been depleted of uranium (Hack 1, 2, 3, Hermit, Pigeon), yielding 7,873 tons U_3O_8, or an average of 1,575 tons U_3O_8 per mine. This was rounded to 1,500 tons U_3O_8, which was also the value selected for use in the ACERT (2009) analysis.
16	Amount of uranium in mines with approved plans of operation (4,587 tons U_3O_8)	–	Estimates of uranium quantity in mines with approved plans were obtained from personal communication (Spiering 2010a) and regulatory filings. Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 from the figure used in the DEIS to account for this discrepancy.
17	Amount of uranium in discovered mineralized breccia pipes for which reserve estimates exist (6,070 tons U_3O_8)	–	Estimates of uranium quantity in seven mineralized breccia pipes were obtained from personal communication (Spiering 2010a) and are based on regulatory filings and in-house reserve estimated conducted by Energy Fuels Nuclear. Historically, estimates of uranium reserves based on surface drilling only underestimate the amount of uranium eventually mined. Based on historical data, surface estimates were increased by a factor of 2.57 from the figure used in the DEIS to account for this discrepancy.
18	Amount of uranium in discovered mineralized breccia pipes without reserve estimates (4,500 tons U_3O_8)	Overall number of discovered mineralized breccia pipes without reserve estimates (19)	Inventory of breccia pipes and mineralization status was obtained from personal communication (Spiering 2010a).
19		Percent of mineralized breccia pipes economically viable to mine (15%)	See ID 26.
20		Number of likely economically viable breccia pipes (3)	15% of 19 discovered mineralized breccia pipes, rounded.

Table B-42. Assumptions Used to Develop Reasonably Foreseeable Development Scenarios, Continued

ID No.	Specific Assumption	Subcomponents of Assumption	Data Sources and Rationale
Quantity of Uranium Available to Mine, continued			
21		Average of 1,500 tons U_3O_8 per mine	See ID 15.
22	Amount of uranium in discovered breccia pipes with unknown mineralization (0 tons U_3O_8)	Overall number of discovered mineralized breccia pipes without reserve estimates (10)	Inventory of breccia pipes and mineralization status was obtained from personal communication (Spiering 2010a).
23		Percent of mineralized breccia pipes economically viable to mine (1%)	Wenrich and Sutphin (1988) estimate that 8% of breccia pipes are mineralized, and 10% of mineralized breccia pipes could be economically viable, yielding 0.8% of breccia pipes that are economical to mine. This is supported by observation that approximately 1,296 breccia pipes have been identified in northern Arizona (Wenrich and Sutphin 1989), resulting in a total of 14 developed ore bodies, or 1.1%.
24		Number of likely economically viable breccia pipes (0)	1% of 10 discovered breccia pipes with unknown mineralization, rounded.
25	Amount of undiscovered uranium resources (24,507 tons U_3O_8)	Estimated undiscovered uranium endowment (163,380 tons U_3O_8)	Taken from the USGS (2010) estimate for the proposed withdrawal area. "Endowment" refers to ore with grades greater than 0.01% U_3O_8. Grades this low are unlikely to be mined; therefore, the entire undiscovered uranium endowment is unlikely to be mined.
26		Percentage of endowment likely to be mined (15%)	Wenrich and Sutphin (1988) estimated that perhaps 10% of mineralized breccia pipes could be economically mined. During this same period, the approximate ore grade for mined breccia pipes was no less than 0.5% U_3O_8.However, some known breccia pipes currently in line for development contain lower grades of ore, as low as 0.25% U_3O_8, which suggests that these lower grades are now considered economically viable to mine as well. This suggests that the minable percentage of the undiscovered uranium endowment should be larger in order to incorporate these lower grades. A similar increase by 50% places the percentage at 15%, which was judged reasonable to incorporate all estimated reserves in known breccia pipes.
27		Amount of minable uranium in undiscovered uranium endowment (24,507 tons U_3O_8)	15% of total endowment of 163,380 tons U_3O_8.
Exploration Activities			
28	Number of field exploration projects per developed mine	Approximate number of exploration projects occurring on BLM and National Forest System lands during 1980s (417)	Data obtained from BLM indicate that 237 exploration projects with drilling occurred during the period from 1980 to1988, resulting in about 5 drill holes per project. The Forest Service reported that 900 drill holes were advanced on National Forest System lands during the 1980s and early 1990s; based on the BLM data, this is estimated to involve about 180 exploration projects, for a total of approximately 417 exploration projects.
29		Number of ore bodies discovered during same period (11)	Based on closed mines (Pigeon, Hermit, Hack Complex), mines with approved plans of operation (Canyon, Kanab North, Pinenut, Arizona 1), and breccia pipes expected to be developed (EZ1, EZ2).

Table B-44. Assumptions Used to Develop Reasonably Foreseeable Development Scenarios, Continued

ID No.	Specific Assumption	Subcomponents of Assumption	Data Sources and Rationale
Exploration Activities, continued			
30		Approximate number of exploration projects yielding a minable ore body (38)	417 / 11.
31	Surface disturbance associated with an exploration project (1.1 acres per project)	–	Provided directly by BLM, based on historic exploration activities.
Haul Roads and Ore Hauling			
32	Miles of new roads for future mines	Average distance to existing road network for North Parcel (0.9 mile)	Average distance determined using GIS and coverage of existing road network; a number of theoretical mines were randomly placed throughout the parcel and the distance from each to the existing road network was calculated. This average distance was multiplied by the estimated number of mines under each alternative. An additional factor of 50% was added to account for the inability to build perfectly linear roads. The underlying assumption is that existing road network would be improved if needed, even if currently not adequate to handle haul traffic.
33		Average distance to existing road network for East Parcel (1.2 miles)	See ID 32.
34		Average distance to existing road network for South Parcel (0.6 mile)	See ID 32.
35	Number of haul trips needed per new mine (11,120)	Average of 1,500 tons U_3O_8 per mine	See ID 15.
36		Average ore grade of 0.54%	Based on known ore grades for 11 unmined breccia pipes in proposed withdrawal area.
37		Average amount of ore to be removed (278,000 tons)	1,500 tons U_3O_8 at 0.54% ore grade.
38		Average capacity of typical haul truck (25 tons)	Based on draft plan of operations for EZ1/EZ2 mine (Denison 2010).
Miles of New Power Lines			
39	Miles of power lines for future mines	–	Assumed power lines would follow road corridor and have be identical in length to new roads.

Table B-44. Assumptions Used to Develop Reasonably Foreseeable Development Scenarios, Continued

ID No.	Specific Assumption	Subcomponents of Assumption	Data Sources and Rationale
Acreage of Surface Disturbance			
40	Surface disturbance from existing mines (0 acres)	–	Assumed surface disturbance for mines with approved plans of operation has already occurred. Acreage of surface disturbance therefore applies only to new mines.
41	Surface disturbance from new mine footprints (20 acres per mine)	–	Various estimates have ranged from 3–4 acres (Wenrich 2009) to 15–20 acres (personal communication, Spiering 2010d) to more than 40 acres (Denison 2010). The high end of this range refers to a mine accessing multiple pipes. Based on historic observations, footprints of existing mines with approved plans of operation, and draft plans of operation, a footprint of 20 acres was selected.
42	Surface disturbance from exploration activities (1.1 acres per exploration project)	–	See ID 31.
43	Surface disturbance from new roads (1.7 acres/mile)	–	Based on width of 14 feet, obtained from draft plan of operation for EZ1/EZ2 mine (Denison 2010).
44	Surface disturbance from power lines (0.17 acre/mile)	–	Calculated as 10% of new road disturbance. Based on impacts from temporary disturbance during construction and permanent pole footprints.
Mine Water Use			
45	Number of wells per mine (1 well)	–	Based on existing mines with approved plans of operation and draft plan of operations for EZ1/EZ2 mine (Denison 2010).
46	Water use (5 gpm)	Water use needed for sanitation and underground drilling (2 gpm)	Based on draft plan of operations for EZ1/EZ2 mine (Denison 2010). Note that these rates are averages over the entire duration and that actual pumping rates from the wells will likely be much higher but for much shorter duration. Mine sites will likely have 10,000- to 20,000-gallon storage capacity (Denison 2010).
47		Water use needed for dust suppression (3 gpm)	Based on approximate capacity of typical water haul truck of 4,000 gallons, assumed to be filled daily.
48	Duration of mine water use (4 years)	–	Assumes water use during development and production phases of mine life; assumes no watering during reclamation except initial establishment.
49	Total water use by each mine over lifetime (10,512,000 gallons)	–	Average water use (5 gpm) × 60 minutes × 24 hours × 365 days × 4 years.
Assumptions Specific to Alternative A (No Withdrawal)			
50	Number of deposits that can be developed under the alternative (30)	Mines with approved plans of operation – 4	All assumed to be developed under scenario.
51		Known mineralized breccia pipes with reserve estimates – 7	All assumed to be developed under scenario; for quantity see ID 17.
52		Known mineralized breccia pipes with no reserve estimates – 3	All assumed to be developed under scenario; for quantity see ID 20.

Table B-44. Assumptions Used to Develop Reasonably Foreseeable Development Scenarios, Continued

ID No.	Specific Assumption	Subcomponents of Assumption	Data Sources and Rationale
Assumptions Specific to Alternative A (No Withdrawal), continued			
53		Breccia pipes with unknown mineralization – 0	All assumed to be developed under scenario, but none expected to yield a mine (see ID 24).
54		Undiscovered uranium resources – 16	All assumed to be developed under scenario; quantity based on available undiscovered uranium (see ID 27), divided by 1,500 tons U_3O_8 per mine (see ID 15).
Assumptions Specific to Alternative B (Proposed Withdrawal)			
55	Number of deposits that can be developed under the alternative (11)	Mines with approved plans of operation – 4	All assumed to be developed under scenario.
56		Known mineralized breccia pipes with reserve estimates – 7	All assumed to be developed under scenario; for quantity see ID 17.
57		Known mineralized breccia pipes with no reserve estimates – 0	Assumed to be unlikely to have valid existing rights.
58		Breccia pipes with unknown mineralization – 0	Assumed to be unlikely to have valid existing rights.
59		Undiscovered uranium resources – 0	Assumed to be unlikely to have valid existing rights.
Assumptions Specific to Alternative C (Partial Withdrawal)			
60	Number of deposits that can be developed under the alternative (18)	Mines with approved plans of operation – 4	All assumed to be developed under scenario.
61		Known mineralized breccia pipes with reserve estimates – 7	All assumed to be developed under scenario; for quantity see ID 17.
62		Known mineralized breccia pipes with no reserve estimates – 1	Of 19 breccia pipes, 5 are located outside the partial withdrawal area and 14 are located within it. Those without are assumed to be developed at a rate of 15% (see ID 20), yielding 1 mine; those within are assumed to be unlikely to have valid existing rights.
63		Breccia pipes with unknown mineralization – 0	Of 10 breccia pipes, 6 are located outside the partial withdrawal area and 4 are located within it. Those without could be developed, but based on assumptions typically only 1% might be economically viable, yielding no mines. Those within are assumed to be unlikely to have valid existing rights
64		Undiscovered uranium resources – 6	Undiscovered uranium endowment reduced based on percentage surface area of the partial withdrawal. See ID 54.

Table B-44. Assumptions Used to Develop Reasonably Foreseeable Development Scenarios, Continued

ID No.	Specific Assumption	Subcomponents of Assumption	Data Sources and Rationale
Assumptions Specific to Alternative D (Partial Withdrawal)			
60	Number of deposits that can be developed under the alternative (26)	Mines with approved plans of operation – 4	All assumed to be developed under scenario.
61		Known mineralized breccia pipes with reserve estimates – 7	All assumed to be developed under scenario; for quantity see ID 17.
62		Known mineralized breccia pipes with no reserve estimates – 3	Of 19 breccia pipes, 17 are located outside the partial withdrawal area and 2 are located within it. Those without are assumed to be developed at a rate of 15% (see ID 20), yielding 3 mines; those within are assumed to be unlikely to have valid existing rights.
63		Breccia pipes with unknown mineralization – 0	Of 10 breccia pipes, 9 are located outside the partial withdrawal area and 1 is located within it. Those without could be developed, but based on assumptions typically only 1% might be economically viable, yielding no mines. Those within are assumed to be unlikely to have valid existing rights.
64		Undiscovered uranium resources – 12	Undiscovered uranium endowment reduced based on percentage surface area of the partial withdrawal. See ID 54.

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Attachment B-1

FEDERAL, STATE, AND LOCAL PERMITS TYPICALLY REQUIRED PRIOR TO MINE DEVELOPMENT

Table B.1-1. Federal, State, and Local Permits Typically Required Prior to Mine Development

Environmental Concern	Permit Authorizations	Agency	Triggering Activity	Timing/Comment
Land Use	43 CFR 3715 and 43 CFR 3802, 3809 BLM Notices, Plans of Operation, and Occupancy (Mining Claims) *(BLM-administered lands)*	Federal Lands, BLM	Activities that ordinarily result in no or negligible disturbance of the public lands or resources are termed “casual use.” In general, the operator may engage in casual use activities without consulting, notifying, or seeking approval from the BLM. For exploration activity greater than casual use and that causes surface disturbance of 5 acres or less of public lands, the operator must file a complete Notice with the responsible BLM Field Office 15 calendar days before commencing operations. A plan of operations is required for surface disturbance greater than casual use, unless the activity qualifies for a Notice filing. Surface disturbance greater than casual use on certain special category lands always requires the operator to file a plan of operations and receive BLM approval.	Within 15 calendar days of receipt of a Notice, the Field Office will review the filing to determine whether it is complete. If the Field Manager takes any of the following actions, operations may not begin until 15 calendar days after filing a complete Notice and providing BLM with an acceptable financial guarantee: • Notifies the operator that BLM needs additional time, not to exceed 15 calendar days, to complete its review; • Notifies the operator that he or she must modify the Notice to prevent unnecessary or undue degradation; • Requires the operator to consult with BLM about the location of existing or proposed access routes; • Determines that an on-site visit is necessary; or • BLM determines that the operator qualifies as a Notice-level operation. The amount of time required to review and approve a plan of operations will vary considerably, depending on the type and complexity of the activity being proposed, the resources potentially affected, the required level of NEPA analysis, the amount of interagency coordination needed, and the level of public controversy. A claimant or operator who is requesting to occupy a mining claim is subject to the same time constraints as a plan of operations.
	Plan of Operations 36 CFR 228 A, Plans of Operation (Mining Claims) *(Forest Service–administered lands)*	Forest Service	Proposals for activities to prospect, mine, or process locatable minerals that might cause significant disturbance of surface resources. A plan of operation is required for activity that uses mechanized earth moving equipment such as bulldozers and or backhoes or requires tree cutting or otherwise may cause significant disturbance of surface resources.	The length of time required to analyze and render a decision varies considerably, depending on the type of operation proposed, public issues, and potential environmental impacts. The process is largely influenced by the type of NEPA documentation that is required. If an EIS is required, the process to complete NEPA and approve a plan of operations may take up to 3 years.
Drilling and Water Use	Dry Well Registration	ADEQ	New dry wells.	Registration must be complete within 30 days of completion of the well. Review time for the registration varies with the complexity of the submittal.
	Notice of Intention to Drill and Abandon an Exploration/ Specialty Well Notice of Intention to Drill, Deepen, Replace, or Modify a Well Notice of Intent to Drill, Deepen, or Modify a Monitor/Piezometer/ Environmental Well Notice of Intent to Abandon a Well	ADWR	Required for any manmade openings in the earth through which water may be withdrawn or obtained from beneath the surface of the earth, including water wells, monitor wells, and piezometer wells. It also applies to all exploration wells and grounding or cathodic protection holes greater than 100 feet deep.	ADWR has a maximum of 15 days to process notices, except as follows: the Notice of Intent to Drill and Abandon an Exploration/Specialty Well and the Notice of Intent to Abandon a Well have 30 days. When a variance, or request to deviate from the minimum construction standards, is submitted, the review period increases to 50 days.
	Withdrawal and Use of Groundwater Well Construction Permit	ADWR	Use of groundwater. Water well completion.	15 to 100 days.
	Appropriations of Surface Water	ADWR	Use or store surface waters	A permit to appropriate water must be reviewed for completeness within 30 days, and a substantive review must be completed in 420 days, for a total overall time frame of 450 days. Permits for reservoir storage must be reviewed for completeness within 30 days and substantive review must be completed in420 days. Severance and transfer of water rights must be completed in an overall time frame of 420 days, including 30 days for completeness review and 390 days for substantive review.
Explosives, Fuel, and Oil	Used Oil Handlers – EPA Identification Number	ADEQ	Transporters/transfer facilities, processors/re-refiners, marketers, and burners of used oil, prior to activity.	Usual processing for the receipt of an EPA Identification Number is about 1 week.
	Permit to Transport Explosives	Bureau of Alcohol, Tobacco and Firearms	Transportation of explosives.	
	Magazine Construction	Bureau of Alcohol, Tobacco and Firearms	Storage of explosives.	
Air Quality	Air Quality Control Permit	ADEQ	Emitting air pollutants.	Depends on the size and complexity of the facility, but usually requires a minimum of 4 months to process.
	Operating Permit (?)	EPA	Release of radon from active underground uranium mines.	

Table B.1-1. Federal, State, and Local Permits Typically Required Prior to Mine Development (Continued)

Environmental Concern	Permit Authorizations	Agency	Triggering Activity	Timing/Comment
Water Quality	Clean Water Act [33 USC 1251 *et seq*., 1341] (Federal Water Pollution Control Act 401)	ADEQ	This certification is issued to ensure that federally permitted or licensed activities do not cause a violation of state water quality standards when an activity may result in a discharge to waters of the state.	Review time depends on the completeness of the information provided to ADEQ, the complexity and size of the proposed activity, and the sensitivity of the impacted watercourse. Typical processing time is 30 days; a complex project with changes may take longer.
	APP	ADEQ	Own or operate a facility that discharges either directly to an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that the pollutant will reach an aquifer. In addition, the following facilities are categorized as discharging facilities: • Surface impoundments, pits, ponds, and lagoons; • Solid waste disposal facilities, except for mining overburden and wall rock that has not been subject to mine leaching operations; • Injection wells; • Land treatment facilities; • Facilities adding pollutants to a salt dome, salt beds, or salt formations, drywells, underground caves, or mines; • Mine tailings piles and ponds; • Mine leaching operations; • Underground water storage facilities (if reclaimed water is recharged); • Sewage treatment facilities, including on-site wastewater treatment facilities; and • Wetlands designed and constructed to treat wastewater for underground storage.	Individual permits are issued for the operational life of the facility. Individual permit review may take from 6 months to more than a year to complete, depending on the complexity of the project, the extent of public involvement, and the responsiveness of the applicant.
	208 Consistency Review	ADEQ	In conjunction with AZPDES or Individual APPs or modification of existing permits.	Consistency review can usually be completed within 1 month, if all necessary information is provided.
	Clean Water Act [33 USC 1251 *et seq*., 1341] (Federal Water Pollution Control Act 401)	ADEQ	When an activity may result in a discharge to waters of the state.	Review time depends on the completeness of the information provided to ADEQ, the complexity and size of the proposed activity, and the sensitivity of the impacted watercourse. Typical processing time is 30 days; a complex project with changes may take longer.
	AZPDES for Stormwater Discharges from Industrial Activities	ADEQ	Discharge from any conveyance that is used for collecting and conveying stormwater and that is directly related to manufacturing, processing, or raw material storage areas at an industrial plant.	For coverage under ADEQ's general stormwater permit, discharges are authorized 48 hours after Notice of Intent is postmarked, unless otherwise notified by ADEQ.
	AZPDES	ADEQ	Discharges of pollutants from point sources into waters of the U.S.	Once a complete AZPDES permit application is received, processing time is generally between 6 months to 1 year, depending on the complexity of the project.
	APP	ADEQ	Own or operate a facility that discharges either directly to an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that the pollutant will reach an aquifer. In addition, the following facilities are categorized as discharging facilities: • Surface impoundments, pits, ponds, and lagoons • Solid waste disposal facilities, except for mining overburden and wall rock that has not been subject to mine leaching operations; • Injection wells; • Land treatment facilities; • Facilities adding pollutants to a salt dome, salt beds, or salt formations, drywells, underground caves, or mines; • Mine tailings piles and ponds; • Mine leaching operations; • Underground water storage facilities (if reclaimed water is recharged); • Sewage treatment facilities, including on-site wastewater treatment facilities; and • Wetlands designed and constructed to treat wastewater for underground storage.	Individual permit review may take from 6 months to more than 1 year to complete, depending on the complexity of the project, the extent of public involvement, and the responsiveness of the applicant.
	Section 404 Permit (also known as a "Dredge and Fill Permit")	U.S. Army Corps of Engineers	Projects that will result in a discharge of dredged or fill material into waters of the U.S., including wetlands.	It takes 30 to 60 days for most general permits and letters of permission. Individual permits typically require 180 days' processing time. Longer processing times may be expected for complex projects or instances where there are endangered species or cultural resource concerns.
	Section 10 Permit	U.S. Army Corps of Engineers	Construction activity in or near or altering any navigable water of the United States must obtain a Section 10 permit. In Arizona, Section 10 applies only to the Colorado River and its impoundments (i.e. Lake Havasu, Lake Mead and Lake Powell).	The individual permit review process typically takes 180 days. Longer processing times may be expected in more complex projects or instances where there are endangered species or cultural resource concerns.
Native Plants	Notice of Intent to Clear Land (Notice)	Arizona Department of Agriculture (ADA)	Arizona Revised Statutes 3-904 requires the property owner, when clearing undisturbed land, to submit a Notice, which notifies the ADA of the intended destruction of protected native plants.	Once submitted, the ADA will return a confirming copy of the Notice to the landowner. The landowner may not begin the destruction of protected native plants until he or she receives confirmation from the ADA and 20 days have elapsed for Notices of less than 1 acre, 30 days have elapsed for notices greater than 1 acre but less than 40 acres, or 60 days have elapsed for Notices involving more than 40 acres.

Table B.1-1. Federal, State, and Local Permits Typically Required Prior to Mine Development (Continued)

Environmental Concern	Permit Authorizations	Agency	Triggering Activity	Timing/Comment
Hazardous Materials	Hazardous Waste Permit	ADEQ	Facility that accepts hazardous waste from off-site for the purpose of treatment, storage, or disposal.	Permit processing time may take 24 months or more, based on the size and complexity of the project.
Solid Waste Disposal	Solid Waste Notification	ADEQ	Site owned, operated, or used for the storage, processing, treatment, or disposal of solid waste.	Notices must be submitted no later than 30 days prior to beginning operation.
Drinking and Wastewater Permits	Discharge Authorization for a Type 4 General APP	ADEQ	On-site wastewater treatment facility.	Regulations allow 73 to 136 business days, depending on the Type 4 General APP. Additional time may be added for more complex facilities.
	Approval to Operate water and/or Wastewater Facilities	ADEQ	New or modified water and/or wastewater facilities.	Typically from 2 to 8 weeks.
	Water and/or Wastewater Facilities – Approval to Construct	ADEQ Groundwater Section	Construction of new or modified water and/or wastewater facilities.	Routine projects are typically processed within 45 to 90 days.
	Reclaimed Water Permit	ADEQ	Wastewater treatment facilities supplying reclaimed water and sites where reclaimed water is applied or used.	Administrative completeness reviews for individual reclaimed water permits are 35 business days, and time frames for substantive reviews for standard and complex facilities range from 186 to 294 business days, depending on the complexity of the project and whether a public hearing is held.
Flood Control	Flood Control	County	Mines proposed for floodplains must be reviewed by the flood control district.	Varies from county to county.
Mine Health and Safety	License to Process Non-radioactive Material from Radioactive Tailings	Arizona Radiation Regulatory Agency (ARRA)	The ARRA is responsible for the conduct of a statewide radiological health and safety program and for the enforcement of state rules and regulations for the control of ionizing radiation. If the primary product is uranium or thorium, the processing of the material is licensed by the United States Nuclear Regulatory Commission. If the processing produces uranium, thorium, or other radioactive material as a secondary product, the licensing is by the ARRA.	120 days.
	Notice of Start-up, Move, or Stop for Portable Mining Equipment and Mine Operations	Arizona State Mine Inspector (ASMI)	Starting, moving, or stopping a mining operation. Use of underground diesel equipment. Elevators at mine property.	The ASMI will notify the mine operator by mail, email, or fax that the Notice has been received and provide the operator with an ASMI ID number. Diesel permits are issued within 30 to 45 days. Elevator permits are issued upon correction of any deficiencies found. If no deficiencies are found, permits are issued upon completion of the inspection.
Wildlife		U.S. Fish and Wildlife Service (USFWS)	The USFWS is not involved in the issuance of mining permits, nor does it authorize mining operations. However, the USFWS may become indirectly involved within the framework of Section 7 of the Endangered Species Act (ESA), as amended. This section of the ESA requires that federal agencies consult with the USFWS on any actions the agency authorizes, funds, or carries out that "may affect" a species listed as endangered or threatened under the ESA, or any designated critical habitat. Consultation is an interagency cooperative process that can either be carried out in conjunction with the permitting agency's NEPA review, or as a separate process. In this regard, permitting agency time lines for the issuance of permits and/or authorizations may be affected by their consultation with the USFWS. Although there is no direct permitting process, persons who "take" a threatened or endangered animal may be subject to civil or criminal penalties under Section 9 of the ESA. The term "take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the USFWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering. Limited protection of listed plants from take is provided to the extent that the ESA prohibits the removal and reduction to possession of federally listed endangered plants or the malicious damage of such plants on areas under federal jurisdiction or the destruction of endangered plants on non-federal areas in violation of state law or regulation or in the course of any violation of a state criminal trespass law.	The ESA requires that if formal consultation is initiated, the consultation be concluded within 90 days and thtat the USFWS's biological opinion be issued within 135 days. Deviations from the normal Section 7 schedules can result when interagency disagreement develops over the alternatives and/or measures needed for the protection of species and habitats in the affected area. These alternatives and/or measures are worked through using the Section 7 process.

Table B.1-1. Federal, State, and Local Permits Typically Required Prior to Mine Development (Continued)

Environmental Concern	Permit Authorizations	Agency	Triggering Activity	Timing/Comment
Cultural Resources	Cultural Resources Use Permit	BLM Forest Service	Compliance with Section 106 of the National Historic Preservation Act is necessary before the BLM/Forest Service approves a mining plan of operations.	A Cultural Resource Use Permit for archaeological survey is usually issued within 1 week of receiving a complete application. A Cultural Resource Use Permit for archaeological testing or excavation (data recovery) cannot be issued until any consultation that may be needed with the State Historic Preservation Officer, Advisory Council on Historic Preservation and the affected American Indian Tribe has been completed by the BLM/Forest Service. Once the BLM/Forest Service has completed the necessary consultation and approved the mitigation plan for cultural resources that will be affected by proposed operations, a Cultural Resource Use Permit for archaeological testing or excavation is usually issued within 1 week of receiving a completed application.
Taxes and Incorporation	Corporations Must File an Application for Authority and Articles of Incorporation	Arizona Corporation Commission	Required of all corporations established in Arizona.	6–8 weeks.
	Transaction Privilege Tax License	Arizona Department of Revenue	Receives gross proceeds from sales or gross income on which a privilege tax is imposed.	The length of time for the Department to issue a transaction privilege tax license and city privilege tax license can be between 10 and 30 business days.

Appendix C

LEGAL DESCRIPTIONS OF LANDS PROPOSED FOR WITHDRAWAL, BY ALTERNATIVE

PROPOSED WITHDRAWAL LEGAL DESCRIPTIONS – ALTERNATIVE B

Gila and Salt River Meridian

South Parcel

T. 28 N., R. 1 E.,
sec. 1;
sec. 2, Lots 1 and 2, S½NE¼, and SE¼;
sec. 11, E½;
sec. 12.

T. 29 N., R. 1 E.,
secs. 1, 2, and, secs. 11 to 14, inclusive;
sec. 23, E½;
secs. 24 and 25;
sec. 26, E½;
sec. 35, NW¼NE¼NE¼, N½NW¼NE¼, SW¼NW¼NE¼, NW¼SE¼NW¼NE¼, NW¼NW¼SW¼NE¼, SE¼SE¼SW¼NE¼, E½SE¼NE¼, E½NW¼SE¼NE¼, SW¼SE¼NE¼, and SE¼;
sec. 36.

T. 30 N., R. 1 E.,
secs. 1, 2, and secs. 11 to 14, inclusive;
secs. 23 to 26, inclusive, secs. 35, and 36.

T. 31 N., R. 1 E.,
sec. 17, Lots 2, 3, S½NE¼, W½, and SE¼;
secs. 18 to 20, inclusive;
sec. 21, Lot 2, W½NE¼, SE¼NE¼, W½, and SE¼;
secs. 27 to 35, inclusive.

T. 28 N., R. 2 E.,
secs. 1 to 6, inclusive;
sec. 7, excluding MS 1419;
secs. 8 to 13, inclusive.

T. 29 N., Rs. 2 to 4 E.

T. 30 N., R. 2 E.,
secs. 2 to 11, inclusive, and secs. 13 to 36, inclusive.

T. 27 N., R. 3 E.,
sec. 1.

T. 28 N., R. 3 E.,
secs. 1 to 18, inclusive, secs. 23 to 25, inclusive, and sec. 36.

T. 30 N., R. 3 E.,
secs. 15 to 36, inclusive.

T. 27 N., R. 4 E.,
secs. 1 to 6, inclusive.

T. 28 N., Rs. 4 and 5 E.

T. 30 N., R. 4 E.,
sec. 13, and secs. 24 to 26, inclusive;
sec. 27, S½;
sec. 28, S½;
sec. 29, S½;
sec. 30, Lots 3 to 7, NE¼SW¼, and N½SE¼;
secs. 31 to 36, inclusive.

T. 27 N., R. 5 E.,
secs. 1 to 6, inclusive.

T. 29 N., R. 5 E., partly unsurveyed.

T. 30 N., R. 5 E.,
secs. 7 to 36, inclusive, unsurveyed.

T. 27 N., R. 6 E.,
secs. 1 to 6, inclusive.

T. 28 N., R. 6 E.,
secs. 2 to 11, inclusive;
sec. 12, S½;
secs. 13 to 36, inclusive.

T. 29 N., R. 6 E.,
secs. 3 to 9, inclusive, secs. 15 and 16, unsurveyed;
secs. 17 to 21, inclusive;
sec. 22, unsurveyed;
secs. 27 to 34, inclusive.

T. 30 N., R. 6 E.,
secs. 7 to 9, inclusive, secs. 15 to 22, inclusive, unsurveyed;
sec. 23, W½;
sec. 26, W½;
secs. 27 to 34, inclusive, unsurveyed.

T. 31 N., R. 1 W.,
sec. 2, Lots 3 and 4, S½NW¼, and SW¼;
secs. 3 and 4, secs. 9 to 11, inclusive, secs. 13 to 16, inclusive, secs. 21 to 28, inclusive, and secs. 33 to 36, inclusive.

North Parcel

T. 40 N., R. 1 E.,
secs. 4 to 9, inclusive, secs. 16 to 21, inclusive, and secs. 28 to 33, inclusive.

T. 41 N., R. 1 E.

T. 38 N., R. 1 W.,
secs. 2 to 4, inclusive, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 5;
secs. 6 to 11, inclusive, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 39 N., R. 1 W.,
secs. 2 to 11, inclusive, secs. 14 to 23, inclusive, and secs. 26 to 35, inclusive.

Tps. 40 to 41 N., R. 1 W.

T. 38 N., R. 2 W.,
secs. 1 to 8, inclusive, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 10 to 12, inclusive, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 39 N., Rs. 2 and 3 W.

T. 40 N., R. 2 W.,
secs. 1 to 3, inclusive, secs. 10 to 15, inclusive, secs. 22 to 27, inclusive, and secs. 31 to 36, inclusive.

T. 37 N., R. 3 W.,
secs. 4 and 5, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 6 and 7, unsurveyed;
secs. 8, 9, 16, and 17, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 18 and 19, unsurveyed;
secs. 20 and 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 29, 30, and 31, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 38 N., R. 3 W.,
secs. 1 to 10, inclusive;
secs. 11 to 14, inclusive, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;

secs. 15 to 22, inclusive;
secs. 23, 26, and 27, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 28 to 32, inclusive;
secs. 33 and 34, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 40 N., R. 3 W.,
secs. 31 to 36, inclusive.

T. 35 N., R. 4 W.,
sec. 5, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 6 and 7, unsurveyed;
sec. 8, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
sec. 17, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 18 and 19, unsurveyed;
sec. 20, unsurveyed, excluding the part within the Grand Canyon National Game Preserve.

T. 36 N., R. 4 W.,
sec. 1, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 2, excluding that part within the Kanab Creek Wilderness;
secs. 3 to 10, inclusive, unsurveyed;
sec. 11, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 12 and 13, unsurveyed, excluding that part within Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 14, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 15 to 22, inclusive, unsurveyed;
sec. 23, unsurveyed, excluding that part within the Kanab Creek Wilderness;
sec. 29, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
sec. 30, unsurveyed.
sec. 31;
sec. 32, unsurveyed, excluding that part within the Grand Canyon National Game Preserve.

T. 37 N., R. 4 W.,
secs. 1 to 3 inclusive, unsurveyed;
sec. 4;
secs. 5 to 8, inclusive, unsurveyed;
sec. 9;
secs. 10 to 15, inclusive, unsurveyed;
secs. 16 to 18;
secs. 19 to 22, inclusive, unsurveyed;
secs. 23 and 24;
secs. 25, unsurveyed;
secs. 26 to 28, inclusive, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 29 to 31, inclusive, unsurveyed;
secs. 32 to 35, inclusive, unsurveyed, excluding that part within the Kanab Creek Wilderness;
sec. 36, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;

Tps. 38 and 39 N., R. 4 W.,

T. 40 N., R. 4 W.,
secs. 31 to 36, inclusive.

T. 35 N., R. 5 W.,
secs. 1 to 24, inclusive.

T. 36 N., Rs. 5 and 6 W.

Tps. 37 to 39 N., Rs. 5 to 7 W.

T. 40 N., R. 5 W.,
secs. 31 to 36, inclusive.

T. 35 N., R. 6 W.,
secs. 1 to 24, inclusive.

T. 35 N. R. 7 W.,
secs. 1 and 2;
secs. 3 to 6, inclusive, excluding that part within the Grand Canyon-Parashant National Monument;
secs. 9 and 10, excluding that part within the Grand Canyon-Parashant National Monument;
secs. 11 to 15, inclusive;
secs. 16, 21, 22, and 23, excluding that part within the Grand Canyon-Parashant National Monument;
sec. 24;
secs. 27 and 28, excluding that part within the Grand Canyon-Parashant National Monument.

T. 36 N., R. 7 W.,
secs. 1 to 32, inclusive;
secs. 33 and 34, excluding that part within the Grand Canyon-Parashant National Monument;
secs. 35 and 36.

East Parcel

T. 37 N., R. 3 E.,
sec. 1, unsurveyed;
secs. 2 and 11 unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 12 and 13, unsurveyed;
sec. 14, unsurveyed, excluding that part within the Grand Canyon National Game Preserve.

T. 38 N., R. 3 E.,
secs. 1 and 2, excluding that part within the Vermilion Cliffs National Monument;
sec. 3, unsurveyed;
secs. 4 and 9, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 10 and 11, unsurveyed;
sec. 12;
secs. 13 to 15, inclusive, unsurveyed;
secs. 16 and 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 22 to 27, inclusive, unsurveyed;
secs. 28 and 35, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
sec. 36, unsurveyed.

T. 39 N., R. 3 E.,

sec. 4, excluding that part within the Grand Canyon National Game Preserve and the Vermilion Cliffs National Monument;
secs. 5 and 8, excluding that part within the Grand Canyon National Game Preserve;
secs. 9 and 15, excluding that part within the Vermilion Cliffs National Monument;
sec. 16;
secs. 17 and 20, excluding that part within the Grand Canyon National Game Preserve;
sec. 21;
secs. 22 and 27, excluding that part within the Vermillion Cliffs National Monument;
sec. 28;
secs. 29 and 32, excluding that part within the Grand Canyon National Game Preserve;
secs. 33 and 34;
sec. 35, excluding that part within the Vermilion Cliffs National Monument.

T. 40 N., R. 3 E.,
secs. 3, 10, and 15, excluding that part within the Vermillion Cliffs National Monument;
sec. 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 22 and 27, excluding that part within the Vermillion Cliffs National Monument;
secs. 28 and 33, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;

T. 36 N., R. 4 E.,
secs. 1 to 5, inclusive;
secs. 6 and 7, excluding that part within the Grand Canyon National Game Preserve;
secs. 8 to 17, inclusive;
secs. 18 to 24, inclusive, excluding that part within the Grand Canyon National Game Preserve.

T. 37 N., R. 4 E.,
secs. 1 to 18, inclusive;
sec. 19, excluding that part within the Grand Canyon National Game Preserve;
secs. 20 to 29, inclusive;
secs. 30 and 31, excluding that part within the Grand Canyon National Game Preserve;
secs. 32 to 36, inclusive.

T. 38 N., R. 4 E.,
secs. 5 and 6, excluding that part within the Vermilion Cliffs National Monument;
sec. 7;
secs. 8 to 13, inclusive, excluding that part within the Vermilion Cliffs National Monument;
secs. 14 to 36, inclusive.

T. 36 N., R. 5 E.,
sec. 2, unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 3 to 9, inclusive;
sec. 10, partly surveyed, excluding that part within the Grand Canyon National Park;
secs. 11 and 15, unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 16, excluding that part within the Grand Canyon National Park;
sec. 17;
sec. 18, excluding that part within the Grand Canyon National Park;
sec. 19, partly unsurveyed, excluding that part within the Grand Canyon National Park and the Grand Canyon National Game Preserve;
sec. 20, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and the Grand Canyon National Park;
secs. 21, unsurveyed, excluding that part within the Grand Canyon National Park.

T. 37 N., R. 5 E.,
secs. 1 to 12, inclusive;
sec. 13, excluding that part within the Grand Canyon National Park;
secs. 14 to 24, inclusive;
sec. 25, unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 26 to 34, inclusive;
sec. 35, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 36, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 38 N., R. 5 E.,
secs. 13 and 14, 16 to 18, inclusive, excluding that part within the Vermilion Cliffs National Monument;
secs. 19 and 20;
secs. 21 to 23, inclusive, excluding that part within the Vermilion Cliffs National Monument;
secs. 24 to 36, inclusive.

T. 37 N., R. 6 E.,
sec. 4, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 5, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 6;
sec. 7, excluding that part within the Grand Canyon National Park;
sec. 8, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 9, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 17, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 18, excluding that part within the Grand Canyon National Park;
sec. 19, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 20 and 30, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 38 N., R. 6 E.,
sec. 1, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
secs. 2 and 3, excluding that part within the Grand Canyon National Park;
secs. 4, 5, 7, and 8, excluding that part within the Vermilion Cliffs National Monument;
secs. 9 and 10;
sec. 11, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 12 and 14, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 15, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 16 and 17;
sec. 18, excluding that part within the Vermilion Cliffs National Monument;
sec. 19;
secs. 20 and 21, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 22 and 27, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
secs. 28 and 29, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 30 to 32, inclusive, excluding that part within the Grand Canyon National Park;
secs. 33, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 39 N., R. 6 E.,
secs. 13, 23, and 24, excluding that part within the Vermilion Cliffs National Monument;
sec. 25;
sec. 26, excluding that part within the Vermilion Cliffs National Monument;
sec. 27, excluding that part within the Vermilion Cliffs National Monument and the Grand Canyon National Park;
sec. 33, S½NE¼, SE¼SW¼, and SE¼, excluding that part within the Vermilion Cliffs National Monument;
secs. 34 and 35, excluding that part within the Grand Canyon National Park;
sec. 36, partly unsurveyed, excluding that part within the Grand Canyon National Park.

T. 39 N., R. 7 E.,
sec. 3, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 4, partly unsurveyed, excluding that part within the Grand Canyon National Park, Vermilion Cliffs National Monument, and Navajo Indian Reservation;
secs. 5, 7, and 8, excluding that part within the Vermilion Cliffs National Monument;
secs. 9 and 16, partly unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 17, excluding that part within the Grand Canyon National Park;
sec. 18, excluding that part within the Vermilion Cliffs National Monument;
sec. 19;
sec. 20, and secs. 29 to 31, inclusive, partly unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 40 N., R. 7 E.,
sec. 33, excluding that part within the Grand Canyon National Park and Vermilion Cliffs National Monument;
sec. 34, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

PROPOSED WITHDRAWAL LEGAL DESCRIPTIONS – ALTERNATIVE C

Gila and Salt River Meridian

South Parcel

T. 28 N., R. 1 E.,
sec. 1;
sec. 2, Lots 1 and 2, S½NE¼, and SE¼;
sec. 11, E½;
sec. 12.

T. 29 N., R. 1 E.,
secs. 1, 2, and secs. 11 to 14, inclusive;
sec. 23, E½;
secs. 24 and 25;
sec. 26, E½;
sec. 35, NW¼NE¼NE¼, N½NW¼NE¼, SW¼NW¼NE¼, NW¼SE¼NW¼NE¼, NW¼NW¼SW¼NE¼, SE¼SE¼SW¼NE¼, E½SE¼NE¼, E½NW¼SE¼NE¼, SW¼SE¼NE¼, and SE¼;
sec. 36.

T. 30 N., R. 1 E.,
secs. 1, 2, and secs. 11 to 14, inclusive;
secs. 23 to 26, inclusive, secs. 35, and 36.

T. 31 N., R. 1 E.,
sec. 17, Lots 2, 3, S½NE¼, W½, and SE¼;
secs. 18 to 20, inclusive;
sec. 21, Lot 2, W½NE¼, SE¼NE¼, W½, and SE¼;
secs. 27 to 35, inclusive.

T. 28 N., R. 2 E.,
secs. 1 to 6, inclusive;
sec. 7, excluding MS 1419;
secs. 8 to 13, inclusive.

T. 29 N., R. 2 E.

T. 30 N., R. 2 E.,
secs. 2 to 11, inclusive, and secs. 13 to 36, inclusive.

T. 28 N., R. 3 E.,
secs. 2 to 11, inclusive, secs. 14 to 18, inclusive, and sec. 23.

T. 29 N., R. 3 E.,
secs. 1 to 12, inclusive;
sec. 13, NE¼, N½NW¼, SE¼NW¼, and NE¼SE¼;
secs. 14 to 23, inclusive;
secs. 26 to 35, inclusive.

T. 30 N., R. 3 E.,
secs. 15 to 36, inclusive.

T. 29 N., R. 4 E.,
secs. 1 to 17, inclusive;
sec. 18, N½, N½SW¼, SE¼SW¼, and SE¼;
sec. 19, NE¼NE¼;
sec. 20, NE¼, and N½NW¼;
sec. 21, N½, NE¼SW¼, and N½SE¼;
secs. 22 to 24, inclusive;
sec. 25, N½NE¼, N½NW¼;
sec. 26, N½NE¼.

T. 30 N., R. 4 E.,
sec. 13, and secs. 24 to 26, inclusive;
sec. 27, S½;
sec. 28, S½;
sec. 29, S½;
sec. 30, Lots 3 to 7, NE¼SW¼, and N½SE¼;
secs. 31 to 36, inclusive.

T. 29 N., R. 5 E.,
secs. 1 to 12, inclusive, unsurveyed;
sec. 13, N½, SW¼, N½SE¼, and SW¼SE¼;
secs. 14 to 19, inclusive;
sec. 20, N½, SW¼, N½SE¼, and SW¼SE¼;
sec. 21, N½, N½SW¼, and N½SE¼ ;
sec. 22, N½;
sec. 23, N½NE¼, and N½NW¼.

T. 30 N., R. 5 E.,
secs. 7 to 36, inclusive, unsurveyed.

T. 29 N., R. 6 E.,
secs. 3 to 9, inclusive, unsurveyed;
sec. 10, N½, N½SW¼, and NW¼SE¼, unsurveyed;
sec. 16, NW¼NW¼, unsurveyed;
sec. 17, N½NE¼, and NW¼;
sec. 18, N½, N½SW¼, and NW ¼SE ¼.

T. 30 N., R. 6 E.,
secs. 7 to 9, inclusive, secs. 15 to 22, inclusive, unsurveyed;
sec. 23, W½;
sec. 26, W½;
secs. 27 to 34, inclusive, unsurveyed.

T. 31 N., R. 1 W.,
sec. 2, Lots 3 and 4, S½NW¼, and SW¼;
secs. 3 and 4, secs. 9 to 11, inclusive, secs. 13 to 16, inclusive, secs. 21 to 28, inclusive, and secs. 33 to 36, inclusive.

North Parcel

T. 38 N., R. 1 W.,
secs. 2 to 4, inclusive, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 5;
secs. 6 to 11, inclusive, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 39 N., R. 1 W.,
sec. 19, S½NE¼, W½, and SE¼;
sec. 20, SW¼, and S½SE¼;
sec. 26, SW¼, and S½SE¼;
sec. 27, S½NW¼, and S½;
sec. 28, W½NE¼, SE¼NE¼, W½, and SE¼;
secs. 29 to 35, inclusive.

T. 38 N., R. 2 W.,
secs. 1 to 8, inclusive, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 10 to 12, inclusive, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 39 N., R. 2 W.,
sec. 3, W½SW¼, and SE¼SW¼;
secs. 4 to 9, inclusive;
sec. 10, W½NE¼, SE¼NE¼, W½, and SE¼;
sec. 11, W½SW¼, SE¼SW¼, and SW¼SE¼;
sec. 13, SW¼NW¼, SW¼, W½SE¼, and SE¼SE¼;
secs. 14 to 36, inclusive.

T. 40 N., R. 2 W.,
secs. 31 and 32;
sec. 33, W½, and W½SE¼.

T. 37 N., R. 3 W.,
secs. 4 and 5, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 6 and 7, unsurveyed;
secs. 8, 9, 16, and 17, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 18 and 19, unsurveyed;
secs. 20 and 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 29, 30, and 31, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 38 N., R. 3 W.,
secs. 1 to 10, inclusive;
secs. 11 to 14, inclusive, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 15 to 22, inclusive;

secs. 23, 26, and 27, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 28 to 32, inclusive;
secs. 33 and 34, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 39 N., R. 3 W.

T. 40 N., R. 3 W.,
secs. 31 to 36, inclusive.

T. 35 N., R. 4 W.,
sec. 5, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 6 and 7, unsurveyed;
sec. 8, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
sec. 17, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 18 and 19, unsurveyed;
sec. 20, unsurveyed, excluding the part within the Grand Canyon National Game Preserve.

T. 36 N., R. 4 W.,
sec. 1, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 2, excluding that part within the Kanab Creek Wilderness;
secs. 3 to 10, inclusive, unsurveyed;
sec. 11, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 12 and 13, unsurveyed, excluding that part within Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 14, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 15 to 22, inclusive, unsurveyed;
sec. 23, unsurveyed, excluding that part within the Kanab Creek Wilderness;
sec. 29, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
sec. 30, unsurveyed.
sec. 31;
sec. 32, unsurveyed, excluding that part within the Grand Canyon National Game Preserve.

T. 37 N., R. 4 W.,
secs. 1 to 3 inclusive, unsurveyed;
sec. 4;
secs. 5 to 8, inclusive, unsurveyed;
sec. 9;
secs. 10 to 15, inclusive, unsurveyed;
secs. 16 to 18;
secs. 19 to 22, inclusive, unsurveyed;
secs. 23 and 24;
secs. 25, unsurveyed;
secs. 26 to 28, inclusive, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 29 to 31, inclusive, unsurveyed;
secs. 32 to 35, inclusive, unsurveyed, excluding that part within the Kanab Creek Wilderness;
sec. 36, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;

Tps. 38 and 39 N., R. 4 W.,

T. 40 N., R. 4 W.,
secs. 31 to 36, inclusive.

T. 35 N., R. 5 W.,
secs. 1 to 24, inclusive.

T. 36 N. to 39 N., R.. 5 W.

T. 40 N., R. 5 W.,
secs. 31 to 36, inclusive.

T. 35 N., R. 6 W.,
secs. 1 to 24, inclusive.

T. 36 N., 6 W.,
secs. 1 to 5, inclusive;
sec. 6, SE¼NE¼, E½SW¼, SW¼SW¼, and SE¼;
secs. 7 to 36, inclusive.

T. 37 N., 6 W.,
secs. 1 to 4, inclusive, and secs. 9 to 15, inclusive;
sec. 16, E½, N½NW¼, SE¼NW¼, and E½SW¼;
sec. 21, E½, E½NW¼, and E½SW¼;
secs. 22 to 27, inclusive;
sec. 28, E½, E½NW¼, and E½SW¼;
sec. 32, SE¼NE¼, E½SE¼, and SW¼SE¼;
secs. 33 to 36, inclusive.

T. 38 N., 6 W.,
secs. 1 to 4, inclusive;
sec. 5, E½, NW¼, N½SW¼, and SE¼SW¼;
sec. 8, NE¼ and NE¼NW¼;
sec. 9, N½, N½SW¼, SE¼SW¼, and SE¼;
secs. 10 to 15, inclusive;
sec. 16, E½, E½NW¼, and SW¼;
sec. 20, SE¼SE¼;
secs. 21 to 28, inclusive;
sec. 29, E½NE¼, and E½SE¼;
sec. 32, E½NE¼, and E½SE¼;
secs. 33 to 36, inclusive.

T. 39 N., 6 W.,
sec. 1;
sec. 2, E½NE¼, SW¼NE¼, and SE¼;
sec. 11, E½, E½NW¼, and SW¼;
secs. 12 to 14, inclusive;
sec. 15, SE¼SE¼;
sec. 22, E½NE¼, and SE¼;
secs. 23 to 26, inclusive;
sec. 27, E½, and SW¼;
sec. 28, S½;
sec. 29, E½SE¼, and SW¼SE¼;

sec. 32, E½, E½NW¼, and SW¼;
secs. 33 to 36, inclusive.

T. 35 N. R. 7 W.,
secs. 1 and 2;
secs. 3 to 6, inclusive, excluding that part within the Grand Canyon-Parashant National Monument;
secs. 9 and 10, excluding that part within the Grand Canyon-Parashant National Monument;
secs. 11 to 15, inclusive;
secs. 16, 21, 22, and 23, excluding that part within the Grand Canyon-Parashant National Monument;
sec. 24;
secs. 27 and 28, excluding that part within the Grand Canyon-Parashant National Monument.

T. 36 N., R. 7 W.,
sec. 1, SE¼SE¼;
sec. 8, S½SE¼;
sec. 9, S½SW¼, and S½SE¼;
sec. 10, SE¼NE¼, E½SW¼, SW¼SW¼, and SE¼;
sec. 11, E½, S½NW¼, and SW¼;
secs. 12 to 32, inclusive;
secs. 33 and 34, excluding that part within the Grand Canyon-Parashant National Monument;
secs. 35 and 36.

East Parcel

T. 37 N., R. 3 E.,
sec. 1, unsurveyed;
secs. 2 and 11 unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 12 and 13, unsurveyed;
sec. 14, unsurveyed, excluding that part within the Grand Canyon National Game Preserve.

T. 38 N., R. 3 E.,
secs. 1 and 2, excluding that part within the Vermilion Cliffs National Monument;
sec. 3, unsurveyed;
secs. 4 and 9, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 10 and 11, unsurveyed;
sec. 12;
secs. 13 to 15, inclusive, unsurveyed;
secs. 16 and 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 22 to 27, inclusive, unsurveyed;
secs. 28 and 35, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
sec. 36, unsurveyed.

T. 39 N., R. 3 E.,
sec. 4, excluding that part within the Grand Canyon National Game Preserve and the Vermilion Cliffs National Monument;
secs. 5 and 8, excluding that part within the Grand Canyon National Game Preserve;
secs. 9 and 15, excluding that part within the Vermilion Cliffs National Monument;
sec. 16;
secs. 17 and 20, excluding that part within the Grand Canyon National Game Preserve;
sec. 21;
secs. 22 and 27, excluding that part within the Vermillion Cliffs National Monument;
sec. 28;

secs. 29 and 32, excluding that part within the Grand Canyon National Game Preserve;
secs. 33 and 34;
sec. 35, excluding that part within the Vermilion Cliffs National Monument.

T. 40 N., R. 3 E.,
secs. 3, 10, and 15, excluding that part within the Vermillion Cliffs National Monument;
sec. 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 22 and 27, excluding that part within the Vermillion Cliffs National Monument;
secs. 28 and 33, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;

T. 36 N., R. 4 E.,
sec. 13, E½, S½NW¼, and SW¼;
sec. 14, SE¼SE¼;
sec. 23, E½NE¼, SW¼NE¼, and SE¼, excluding that part within the Grand Canyon National Game Preserve;
sec. 24, excluding that part within the Grand Canyon National Game Preserve.

T. 37 N., R. 4 E.,
secs. 1 and 2;
sec. 3, N½, N½SW¼, N½SE¼ , and SE¼SE¼;
sec. 4, N½;
sec. 5, N½NE¼ and NE¼NW¼;
sec. 6, W½NW¼, and W½SW¼;
sec. 7, W½NW¼, and W½SW¼;
sec. 11, N½NE¼;
sec. 12, NE¼, N½NW¼, and SE¼NW¼;
sec. 18, W½NW¼, and W½SW¼.

T. 38 N., R. 4 E.,
secs. 5 and 6, excluding that part within the Vermilion Cliffs National Monument;
sec. 7;
secs. 8 to 13, inclusive, excluding that part within the Vermilion Cliffs National Monument;
secs. 14 to 30, inclusive;
sec. 31, N½, N½SW¼, SW¼SW¼, and SE ¼;
secs. 32 to 36, inclusive.

T. 36 N., R. 5 E.,
sec. 2, unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 3, E½, and E½SW¼;
sec. 7, S½SW¼, and S½SE¼;
sec. 8, S½SW¼, and S½SE¼;
sec. 9, SE¼NE¼, S½SW¼, and SE¼;
sec. 10, partly surveyed, excluding that part within the Grand Canyon National Park;
secs. 11 and 15, unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 16, excluding that part within the Grand Canyon National Park;
sec. 17;
secs. 18, excluding that part within the Grand Canyon National Park;
sec. 19, partly unsurveyed, excluding that part within the Grand Canyon National Park and the Grand Canyon National Game Preserve;
sec. 20, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and the Grand Canyon National Park;
secs. 21, unsurveyed, excluding that part within the Grand Canyon National Park.

T. 37 N., R. 5 E.,
secs. 1 to 6, inclusive;
sec. 7, N½, N½SW¼, and N½SE¼;
sec. 8, N½, N½SW¼, SE¼SW¼, and SE¼;
sec. 9;
sec. 10, N½, N½SW¼, and N½SE¼;
sec. 11, N½, NW¼SW¼, and E½SE¼;
sec. 12;
sec. 13, excluding that part within the Grand Canyon National Park;
sec. 14, E½, SE¼NW¼, and E½SW¼;
sec. 23, E½, E½NW¼, SW¼NW¼, E½SW¼, and NW¼SW¼;
sec. 24;
sec. 25, unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 26, E½, E½NW¼, E½SW¼, and SW¼SW¼;
sec. 34, SE¼NE¼, E½SE¼, and SW¼SE¼;
sec. 35, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 36, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 38 N., R. 5 E.,
secs. 13 and 14, 16 to 18, inclusive, excluding that part within the Vermilion Cliffs National Monument;
secs. 19 and 20;
secs. 21 to 23, inclusive, excluding that part within the Vermilion Cliffs National Monument;
secs. 24 to 36, inclusive.

T. 37 N., R. 6 E.,
sec. 4, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 5, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 6;
sec. 7, excluding that part within the Grand Canyon National Park;
sec. 8, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 9, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 17, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 18, excluding that part within the Grand Canyon National Park;
sec. 19, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 20 and 30, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.
T. 38 N., R. 6 E.,
sec. 1, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
secs. 2 and 3, excluding that part within the Grand Canyon National Park;
secs. 4, 5, 7, and 8, excluding that part within the Vermilion Cliffs National Monument;
secs. 9 and 10;
sec. 11, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 12 and 14, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 15, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 16 and 17;
sec. 18, excluding that part within the Vermilion Cliffs National Monument;
sec. 19;

secs. 20 and 21, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 22 and 27, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
secs. 28 and 29, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 30 to 32, inclusive, excluding that part within the Grand Canyon National Park;
secs. 33, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 39 N., R. 6 E.,
secs. 13, 23, and 24, excluding that part within the Vermilion Cliffs National Monument;
sec. 25;
sec. 26, excluding that part within the Vermilion Cliffs National Monument;
sec. 27, excluding that part within the Vermilion Cliffs National Monument and the Grand Canyon National Park;
sec. 33, S½NE¼, SE¼SW¼, and SE¼, excluding that part within the Vermilion Cliffs National Monument;
secs. 34 and 35, excluding that part within the Grand Canyon National Park;
sec. 36, partly unsurveyed, excluding that part within the Grand Canyon National Park.

T. 39 N., R. 7 E.,
sec. 3, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 4, partly unsurveyed, excluding that part within the Grand Canyon National Park, Vermilion Cliffs National Monument, and Navajo Indian Reservation;
secs. 5, 7, and 8, excluding that part within the Vermilion Cliffs National Monument;
secs. 9 and 16, partly unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 17, excluding that part within the Grand Canyon National Park;
sec. 18, excluding that part within the Vermilion Cliffs National Monument;
sec. 19;
sec. 20, and secs. 29 to 31, inclusive, partly unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 40 N., R. 7 E.,
sec. 33, excluding that part within the Grand Canyon National Park and Vermilion Cliffs National Monument;
sec. 34, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

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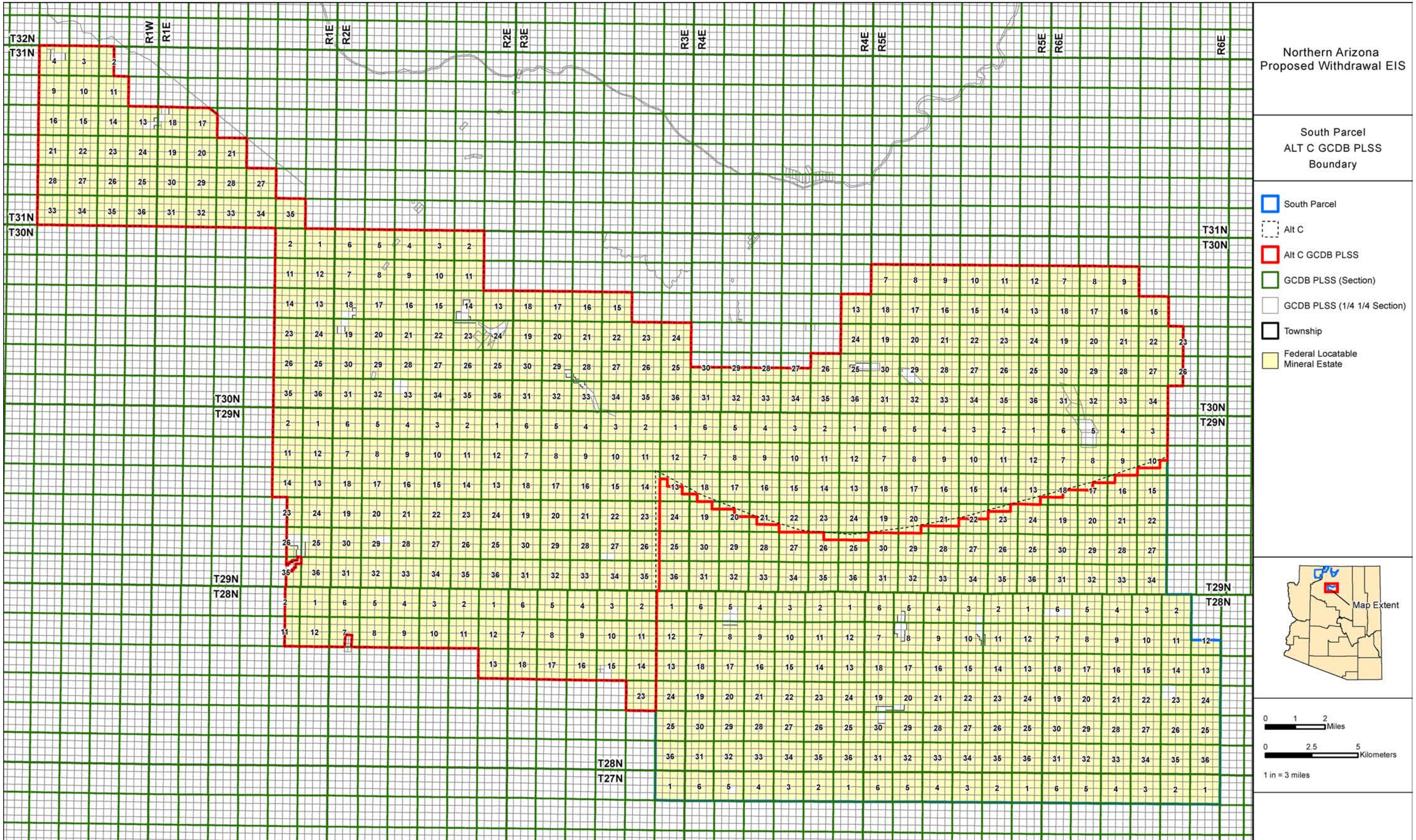
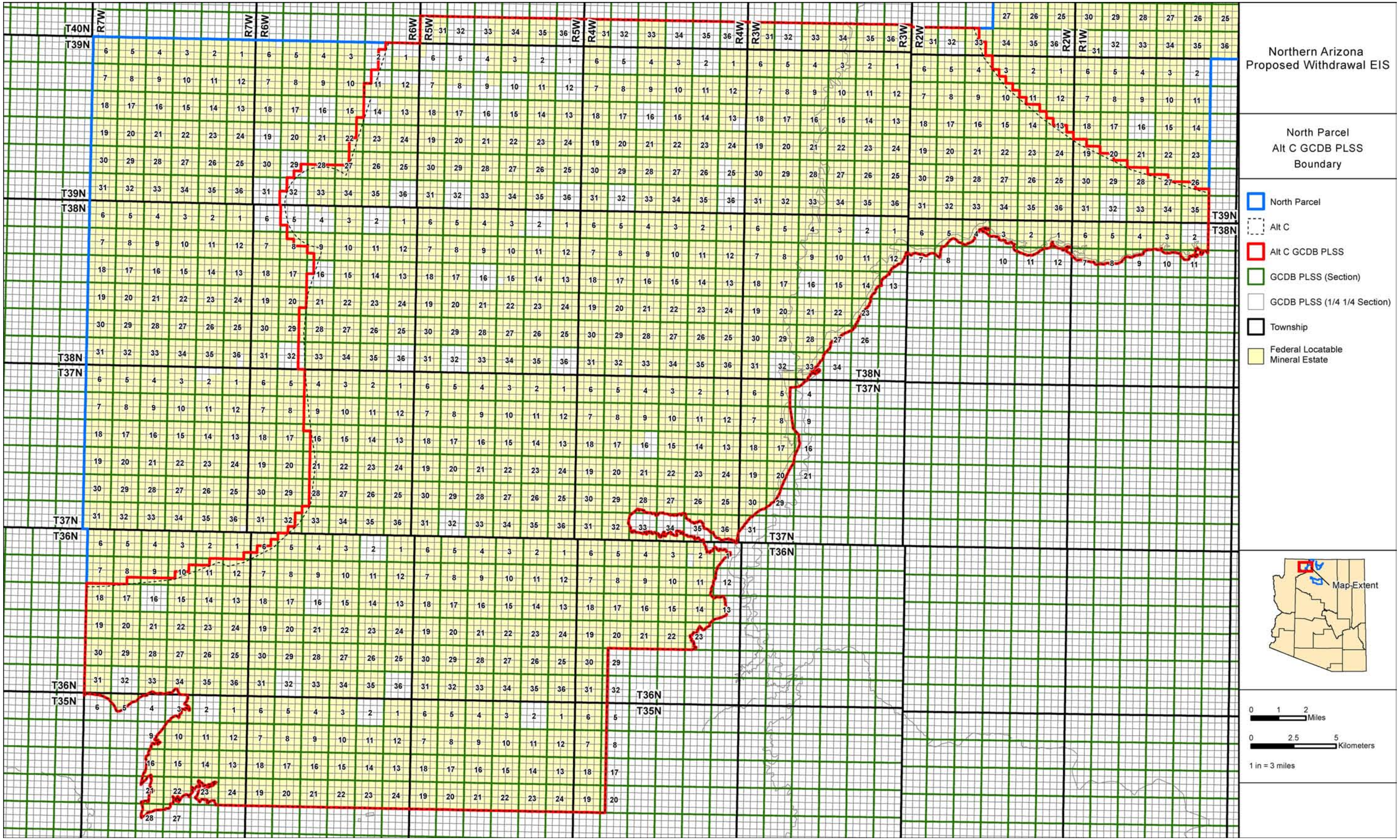
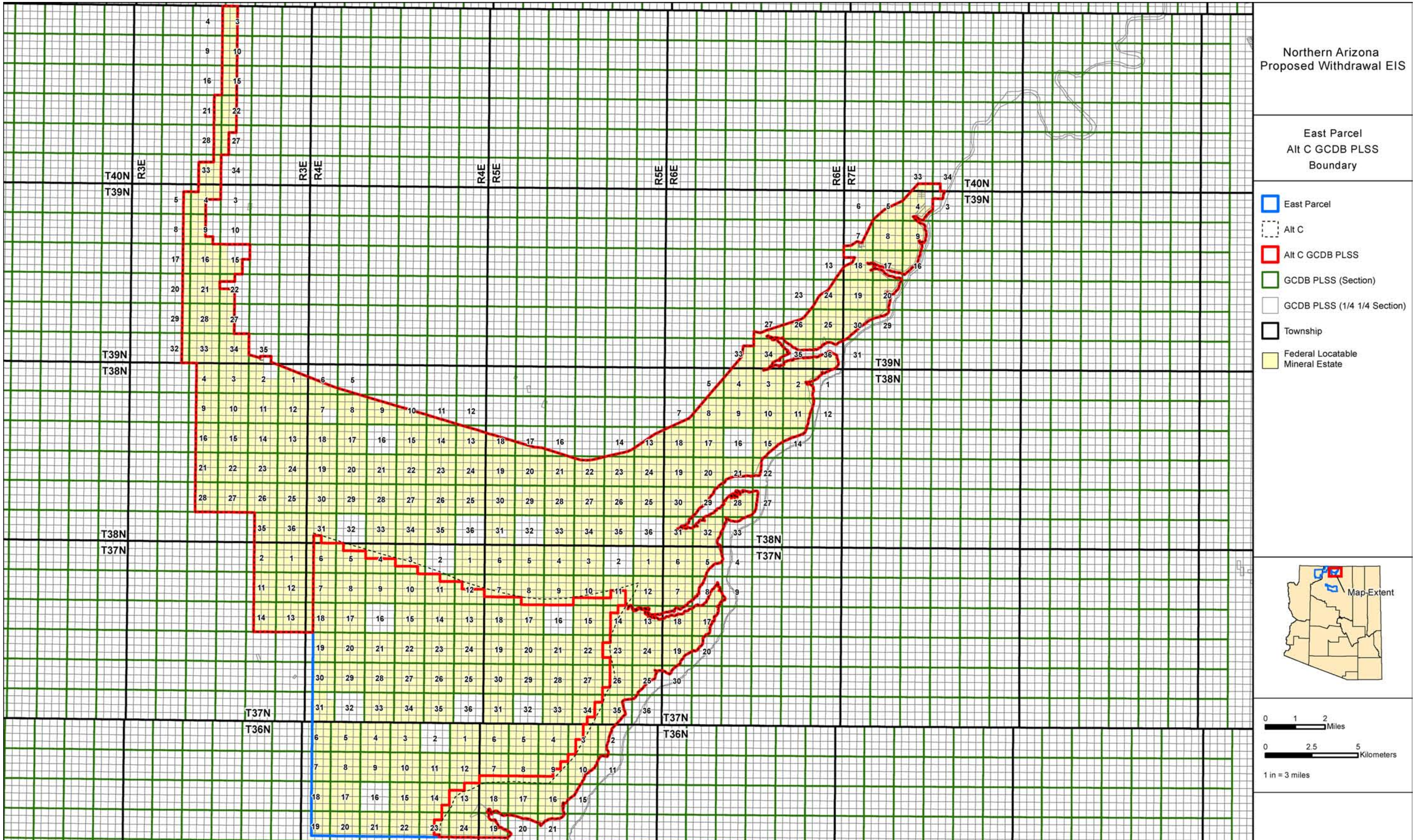

Northern Arizona Proposed Withdrawal EIS
South Parcel
ALT C GCDB PLSS
Boundary
South Parcel
Alt C
Alt C GCDB PLSS
GCDB PLSS (Section)
GCDB PLSS (1/4 1/4 Section)
Township
Federal Locatable Mineral Estate
Map Extent
0 1 2 Miles
0 2.5 5 Kilometers
1 in = 3 miles
T32N
T31N
T30N
T29N
T28N
T27N
R1W
R1E
R2E
R3E
R4E
R5E
R6E


Northern Arizona Proposed Withdrawal EIS
North Parcel Alt C GCDB PLSS Boundary
North Parcel
Alt C
Alt C GCDB PLSS
GCDB PLSS (Section)
GCDB PLSS (1/4 1/4 Section)
Township
Federal Locatable Mineral Estate
Map Extent
0 1 2 Miles
0 2.5 5 Kilometers
1 in = 3 miles
T40N
T39N
T38N
T37N
T36N
T35N
R7W
R6W
R5W
R4W
R3W
R2W
R1W


Northern Arizona
Proposed Withdrawal EIS
East Parcel
Alt C GCDB PLSS
Boundary
East Parcel
Alt C
Alt C GCDB PLSS
GCDB PLSS (Section)
GCDB PLSS (1/4 1/4 Section)
Township
Federal Locatable
Mineral Estate
Map Extent
0 1 2 Miles
0 2.5 5 Kilometers
1 in = 3 miles
T40N
T39N
T38N
T37N
T36N
R3E
R4E
R5E
R6E
R7E

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PROPOSED WITHDRAWAL LEGAL DESCRIPTIONS – ALTERNATIVE D

Gila and Salt River Meridian

South Parcel

T. 29 N., R. 1 E.,
sec. 1, N½NW¼ and SW¼NW¼;
sec. 2, N½, SW¼, N½SE¼, and SW¼SE¼;
sec. 11, NW¼NE¼, N½NW¼, and SW¼NW¼.

T. 30 N., R. 1 E.,
secs. 1, 2, and secs. 11 to 14, inclusive;
secs. 23 to 26, inclusive;
sec. 35;
sec. 36, N½, SW¼, N½SE¼, and SW¼SE¼.

T. 31 N., R. 1 E.,
sec. 17, Lots 2, 3, S½NE¼, W½, and SE¼;
secs. 18 to 20, inclusive;
sec. 21, Lot 2, W½NE¼, SE¼NE¼, W½, and SE¼;
secs. 27 to 35, inclusive.

T. 30 N., R. 2 E.,
secs. 2 to 11, inclusive, secs. 13 to 24, inclusive;
sec. 25, N½, N½SW¼, N½SE¼, and SE¼SE¼;
sec. 26, N½ and NE¼SE¼;
sec. 27, N½NE¼, SE¼NE¼, and N½NW¼;
sec. 28, NE¼NE¼;
sec. 29, NW¼NE¼, N½NW¼, and SW¼NW¼;
sec. 30, N½, SW¼, and N½SE¼;
sec. 31, N½NW¼, and SW¼NW¼.

T. 29 N., R. 3 E.,
secs. 1 to 3, inclusive;
sec. 4, NE¼, N½NW¼, SE¼NW¼, and N½SE¼;
sec. 10, N½NE¼, SE¼NE¼, and NE¼NW¼;
sec. 11, N½, N½SW¼, and SE¼;
sec. 12;
sec. 13, NE¼, N½NW¼, SE¼NW¼, and NE¼SE¼;
sec. 14, NE¼NE¼.

T. 30 N., R. 3 E.,
secs. 15 to 30, inclusive;
sec. 31, N½NE¼;
sec. 32, NE¼, N½NW¼, SE¼NW¼, N½SE¼, and SE¼SE¼;
secs. 33 to 36, inclusive.

T. 29 N., R. 4 E.,
secs. 1 to 17, inclusive;
sec. 18, N½, N½SW¼, SE¼SW¼, and SE¼;
sec. 19, NE¼NE¼;
sec. 20, NE¼ and N½NW¼;
sec. 21, N½, NE¼SW¼, and N½SE¼;
secs. 22 to 24, inclusive;
sec. 25, N½NE¼, and N½NW¼;
sec. 26, N½NE¼.

T. 30 N., R. 4 E.,
sec. 13, and secs. 24 to 26, inclusive;
sec. 27, S½;
sec. 28, S½;
sec. 29, S½;
sec. 30, Lots 3 to 7, NE¼SW¼, and N½SE¼;
secs. 31 to 36, inclusive.

T. 29 N., R. 5 E.,
secs. 1 to 12, inclusive, unsurveyed;
sec. 13, N½, SW¼, N½SE¼, and SW¼SE¼;
secs. 14 to 19, inclusive;
sec. 20, N½, SW¼, N½SE¼, and SW¼SE¼;
sec. 21, N½, N½SW¼, and N½SE¼;
sec. 22, N½;
sec. 23, NW¼NE¼, and N½NW¼.

T. 30 N., R. 5 E.,
secs. 7 to 36, inclusive, unsurveyed.

T. 29 N., R. 6 E.,
secs. 3 to 9, inclusive, unsurveyed;
sec. 10, N½, N½SW¼, and NW¼SE¼, unsurveyed;
sec. 16, NW¼NW¼, unsurveyed;
sec. 17, N½NE¼, and NW¼;
sec. 18, N½, and N½SW¼.

T. 30 N., R. 6 E.,
secs. 7 to 9, inclusive, secs. 15 to 22, inclusive, unsurveyed;
sec. 23, W½;
sec. 26, W½;
secs. 27 to 34, inclusive, unsurveyed.

T. 31 N., R. 1 W.,
sec. 2, Lots 3 and 4, S½NW¼, and SW¼;
secs. 3 and 4, secs. 9 to 11, inclusive, secs. 13 to 16, inclusive, secs. 21 to 28, inclusive, and secs. 33 to 36, inclusive.

North Parcel

T. 38 N., R. 1 W.,
sec. 2, S½NE¼, S½NW¼, and S½, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 3, S½NE¼, S½NW¼, and S½, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 4, S½, excluding that part within the Grand Canyon National Gamer Preserve and Kanab Creek Wilderness;
sec. 5, S½SW¼, and S½SE¼;
sec. 6, SW¼NW¼, SW¼, W½SE¼, and SE¼SE¼, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 7 to 11, inclusive, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;

T. 38 N., R. 2 W.,
sec. 1, S½NE¼, S½NW¼, and S½, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 2, S½NE¼, NW¼NW¼, S½NW¼, and S½, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 3 and 4, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 5, NE¼, E½NW¼, SW¼NW¼, and S½, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 6, S½, unsurveyed;
secs. 7 and 8, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 10 to 12, inclusive, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;

T. 39 N., R. 2 W.,
sec. 18, SW¼SW¼;
sec. 19, SW¼NE¼, W½NW¼, SE¼NW¼, and S½;
sec. 30, N½;
sec. 33, S½SW¼ , and S½SE¼ ;
sec. 34, S½SW¼.

T. 37 N., R. 3 W.,
secs. 4 and 5, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 6, NE¼, W½NW¼, SE¼NW¼, and S½, unsurveyed;
sec. 7, unsurveyed;
secs. 8, 9, and 16, and 17, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 18 and 19, unsurveyed;
secs. 20 and 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 29, 30, and 31, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 38 N., R. 3 W.,
sec. 1, NE¼SW¼, S½SW¼, and SE¼;
secs. 2 to 10, inclusive;
sec. 11, E½NE¼, N½NW¼, SE¼SW¼, and SE¼;
secs. 12 and 13, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 14, NE¼, E½NW¼, SW¼NW¼, and S½, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 15, N½, SW¼, and W½SE¼;
secs. 16 and 17;
sec. 18, E½, NW¼, and E½SW¼;
sec. 19, E½;
secs. 20 to 22, inclusive;
secs. 23, 26, and 27, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
secs. 28 and 29;
sec. 30, E½;
sec. 31, E½, and E½SW¼;
sec. 32;
secs. 33 and 34, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;

T. 39 N., R. 3 W.
sec. 2, S½NE¼, W½, and SE¼;
sec. 3;
sec. 4, E½, NE¼SW¼, and S½SW¼;
sec. 5, SW¼NE¼, W½, and SE¼;
sec. 6, E½, E½NW¼, E½SW¼, and SW¼SW¼;
secs. 7 to 10, inclusive;
sec. 11, N½NE¼, SW¼NE¼, W½, W½SE¼, and SE¼SE¼;
sec. 12, SW¼SW¼;
sec. 13, W½NW¼, SE¼NW¼, SW¼, W½SE¼, and SE¼SE¼;
secs. 14 to 24, inclusive;
sec. 25, N½, SW¼, N½SE¼, and SW¼SE¼;
secs. 26 to 34, inclusive;
sec. 35, W½NE¼, W½, and SE¼.

T. 40 N., R. 3 W.,
sec. 31, SE¼SW¼ and S½SE¼;
sec. 32, SW¼SW¼;
sec. 33, S½NE¼ and SE¼;
sec. 34, S½SW¼, and S½SE¼.

T. 36 N., R. 4 W.,
sec. 1, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;
sec. 2, excluding that part within the Kanab Creek Wilderness;
secs. 3 to 10, inclusive, unsurveyed;
sec. 11, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 12 and 13, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness;

sec. 14, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 15 to 22, inclusive, unsurveyed;
sec. 23, unsurveyed, excluding that part within the Kanab Creek Wilderness.

T. 37 N., R. 4 W.,
secs. 1 to 3 inclusive, unsurveyed;
sec. 4;
sec. 9, E½, E½NW¼ , NW¼NW¼, and E½SW¼;
secs. 10 to 14, inclusive, unsurveyed;
sec. 15, N½ and NE¼SE¼, unsurveyed;
sec. 16, N½NE¼;
sec. 19, S½NE¼, W½, and SE¼, unsurveyed;
sec. 20, S½NE¼, S½NW¼, and S½, unsurveyed;
sec. 21, S½NW¼ and S½, unsurveyed;
sec. 22, SW¼ and S½SE¼, unsurveyed;
sec. 23, E½ and SW¼SW¼;
sec. 24;
sec. 25, unsurveyed;
secs. 26 to 28, inclusive, unsurveyed, excluding that part within the Kanab Creek Wilderness;
secs. 29 to 31, inclusive, unsurveyed;
secs. 32 to 35, inclusive, unsurveyed, excluding that part within the Kanab Creek Wilderness;
sec. 36, unsurveyed, excluding that part within the Grand Canyon National Game Preserve and Kanab Creek Wilderness.

T. 38 N., R. 4 W.,
sec. 1, E½;
sec. 12, NE¼, and E½SE¼;
sec. 19, SE¼SE¼;
sec. 20, S½NE¼, and S½;
sec. 21, S½NE¼, S½NW¼, and S½;
sec. 22, SW¼NE¼, S½NW¼, and S½;
sec. 23, SW¼ and SW¼SE¼;
sec. 25, W½SW¼;
secs. 26 to 28, inclusive;
sec. 29, N½, E½SW¼, and SE¼;
sec. 30, NE¼NE¼;
sec. 32, N½NE¼, SE¼NE¼, and NE¼SE¼;
secs. 33 to 35, inclusive;
sec. 36, W½, W½SE¼, and SE¼SE¼.

T. 39 N., R. 4 W.,
sec. 1, S½SW¼, S½SE¼;
sec. 2, S½SW¼, S½SE¼;
sec. 3, SE¼SE¼;
sec.10, E½, SE¼NW¼, E½SW¼, and SW¼SW¼;
secs. 11 to 15, inclusive;
sec. 22, NE¼, N½NW¼, SE¼NW¼, and N½SE¼;
sec. 23, N½, N½SW¼, and N½SE¼;
sec. 24, E½, NW¼, and E½SW¼;
sec. 25, E½ and NE¼NW¼;
sec. 36, NE¼NE¼ and S½SE¼;

T. 36 N., R. 5 W.
secs. 1 and 2;
sec. 3, N½, SW¼, W½SE¼, and SE¼SE¼;
sec. 4;
sec. 5, E½, E½NW¼, and E½SW¼;
sec. 8, E½, E½NW¼, and E½SW¼;
secs. 9 and 10;
sec. 11, E½ and NE¼NW¼;
sec. 12;
sec. 13, N½, N½SW¼, SE¼SW¼, and SE¼;
sec. 14, E½NE¼;
secs. 15 and 16;
sec. 17, E½, E½NW¼, and E½SW¼;
sec. 20, NE¼, E½NW¼, NE¼SW¼, and N½SE¼;
sec. 21, N½, N½SW¼, and N½SE¼;
sec. 22, N½NE¼, SW¼NE¼, NW¼, and N½SW¼;
sec. 24, NE¼ and E½SE¼.

T. 37 N., R. 5 W.
sec. 8, E½SE¼;
sec. 9, E½, S½NW¼, and SW¼;
sec. 10, W½NE¼, SE¼NE¼, W½, and SE¼;
sec. 11, SW¼NW¼, W½SW¼, and SE¼SW¼;
sec. 13, SW¼, W½SE¼, and SE¼SE¼;
sec. 14, S½NE¼, W½, and SE¼;
secs. 15 and 16;
sec. 17, E½, E½NW¼, SW¼NW¼, and SW¼;
sec. 18, E½SE¼, and SW¼SE¼;
sec. 19, E½;
secs. 20 to 29;
sec. 30, E½;
sec. 31, N½NE¼, SE¼NE¼, and NE¼SE¼;
sec. 32, N½, N½SW¼, SE¼SW¼, and SE¼;
secs. 33 to 36, inclusive.

East Parcel

T. 37 N., R. 3 E.,
sec. 1, unsurveyed;
secs. 2 and 11 unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 12 and 13, unsurveyed;
sec. 14, unsurveyed, excluding that part within the Grand Canyon National Game Preserve.

T. 38 N., R. 3 E.,
secs. 1 and 2, excluding that part within the Vermilion Cliffs National Monument;
sec. 3, unsurveyed;
secs. 4 and 9, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 10 and 11, unsurveyed;
sec. 12;
secs. 13 to 15, inclusive, unsurveyed;
secs. 16 and 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;

secs. 22 to 27, inclusive, unsurveyed;
secs. 28 and 35, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
sec. 36, unsurveyed.

T. 39 N., R. 3 E.,
sec. 4, excluding that part within the Grand Canyon National Game Preserve and the Vermilion Cliffs National Monument;
secs. 5 and 8, excluding that part within the Grand Canyon National Game Preserve;
secs. 9 and 15, excluding that part within the Vermilion Cliffs National Monument;
sec. 16;
secs. 17 and 20, excluding that part within the Grand Canyon National Game Preserve;
sec. 21;
secs. 22 and 27, excluding that part within the Vermillion Cliffs National Monument;
sec. 28;
secs. 29 and 32, excluding that part within the Grand Canyon National Game Preserve;
secs. 33 and 34;
sec. 35, excluding that part within the Vermilion Cliffs National Monument.

T. 40 N., R. 3 E.,
secs. 3, 10, and 15, excluding that part within the Vermillion Cliffs National Monument;
sec. 21, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;
secs. 22 and 27, excluding that part within the Vermillion Cliffs National Monument;
secs. 28 and 33, unsurveyed, excluding that part within the Grand Canyon National Game Preserve;

T. 36 N., R. 4 E.,
sec. 13, E½, S½NW¼, and SW¼;
sec. 14, SE¼SE¼;
sec. 23, E½NE¼, SW¼NE¼, and SE¼, excluding that part within the Grand Canyon National Game Preserve;
sec. 24, excluding that part within the Grand Canyon National Game Preserve;

T. 37 N., R. 4 E.,
sec. 6, W½NW¼, and W½SW¼;
sec. 7, W½NW¼, and W½SW¼;
sec. 18, W½NW¼, and W½SW¼.

T. 38 N., R. 4 E.,
sec. 6, SW¼NW¼, and W½SW¼, excluding that part within the Vermilion Cliffs National Monument;
sec. 7, W½NW¼, and W½SW¼;
sec. 18, W½NW¼, and W½SW¼;
sec. 19, W½NW¼, and W½SW¼;
sec. 30, W½NW¼, and W½SW¼;
sec. 31, W½NW¼, and W½SW¼.

T. 36 N., R. 5 E.,
sec. 2, unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 3, E½, and E½SW¼;
sec. 7, S½SW¼, and S½SE¼;
sec. 8, S½SW¼, and S½SE¼;
sec. 9, SE¼NE¼, S½SW¼, and SE¼;
sec. 10, partly surveyed, excluding that part within the Grand Canyon National Park;

secs. 11 and 15, unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 16, excluding that part within the Grand Canyon National Park;
sec. 17;
sec. 18, excluding that part within the Grand Canyon National Park;
sec. 19, partly unsurveyed, excluding that part within the Grand Canyon National Park and the Grand Canyon National Game Preserve;
secs. 20, unsurveyed, excluding that part within the Grand Canyon National Park and the Grand Canyon National Game Preserve;
Sec. 21, unsurveyed, excluding that part within the Grand Canyon National Park.

T. 37 N., R. 5 E.,
sec. 1, E½, and E½SW¼;
sec. 11, E½SE¼;
sec. 12;
sec. 13, excluding that part within the Grand Canyon National Park;
sec. 14, E½, SE¼NW¼, and E½SW¼;
sec. 23, E½, E½NW¼, SW¼NW¼, E½SW¼, and NW¼SW¼;
sec. 24;
sec. 25, unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 26, E½, E½NW¼, E½SW¼, and SW¼SW¼;
sec. 34, SE¼NE¼, E½SE¼, and SW¼SE¼;
sec. 35, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 36, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 38 N., R. 5 E.,
sec. 25, S½NE¼, SE¼SW¼, and SE¼;
sec. 36, E½, E½NW¼, and NE¼SW¼;

T. 37 N., R. 6 E.,
sec. 4, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 5, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 6;
sec. 7, excluding that part within the Grand Canyon National Park;
sec. 8, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 9, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 17, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 18, excluding that part within the Grand Canyon National Park;
sec. 19, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 20 and 30, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 38 N., R. 6 E.,
sec. 1, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
secs. 2 and 3, excluding that part within the Grand Canyon National Park;
secs. 4, excluding that part within the Vermilion Cliffs National Monument;
sec. 5, SE¼NE¼, and SE¼, excluding that part within the Vermilion Cliffs National Monument;
sec. 8, E½, and E½SW¼, excluding that part within the Vermilion Cliffs National Monument;

secs. 9 and 10;
sec. 11, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 12 and 14, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 15, partly unsurveyed, excluding that part within the Grand Canyon National Park;
sec. 16;
sec. 17, E½, E½NW¼, SW¼NW¼, and SW¼;
sec. 18, SE¼SE¼;
sec. 19, E½NE¼, and SE¼;
secs. 20 and 21, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 22 and 27, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
secs. 28 and 29, partly unsurveyed, excluding that part within the Grand Canyon National Park;
secs. 30 to 32, inclusive, excluding that part within the Grand Canyon National Park;
secs. 33, unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 39 N., R. 6 E.,
secs. 13, 23, and 24, excluding that part within the Vermilion Cliffs National Monument;
sec. 25;
sec. 26, excluding that part within the Vermilion Cliffs National Monument;
sec. 27, excluding that part within the Vermilion Cliffs National Monument and the Grand Canyon National Park;
sec. 33, S½NE¼, SE¼SW¼, and SE¼, excluding that part within the Vermilion Cliffs National Monument;
secs. 34 and 35, excluding that part within the Grand Canyon National Park;
sec. 36, partly unsurveyed, excluding that part within the Grand Canyon National Park.

T. 39 N., R. 7 E.,
sec. 3, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 4, partly unsurveyed, excluding that part within the Grand Canyon National Park, Vermilion Cliffs National Monument, and Navajo Indian Reservation;
secs. 5, 7, and 8, excluding that part within the Vermilion Cliffs National Monument;
secs. 9 and 16, partly unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation;
sec. 17, excluding that part within the Grand Canyon National Park;
sec. 18, excluding that part within the Vermilion Cliffs National Monument;
sec. 19;
sec. 20, and secs. 29 to 31, inclusive, partly unsurveyed, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

T. 40 N., R. 7 E.,
sec. 33, excluding that part within the Grand Canyon National Park and Vermilion Cliffs National Monument;
sec. 34, excluding that part within the Grand Canyon National Park and Navajo Indian Reservation.

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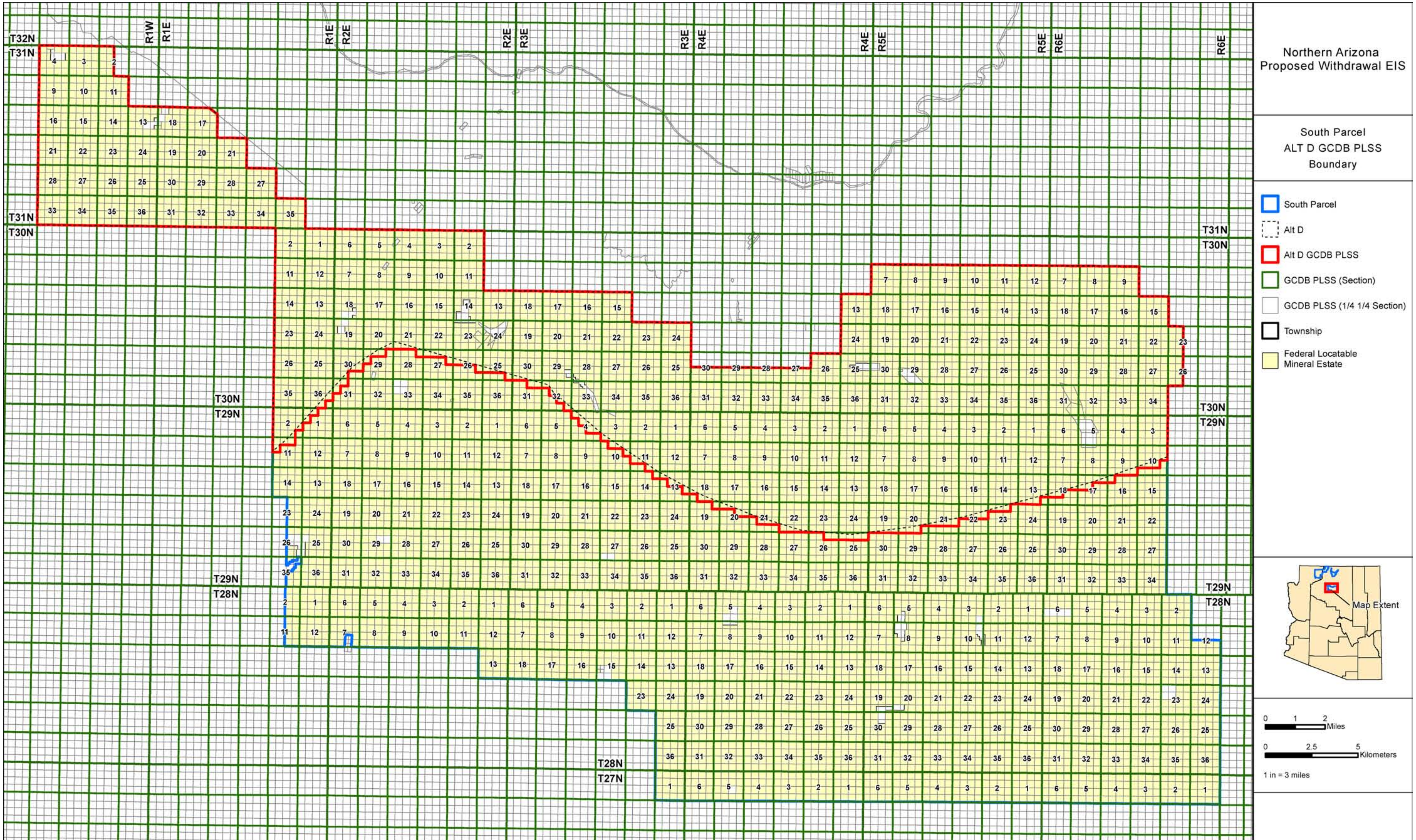
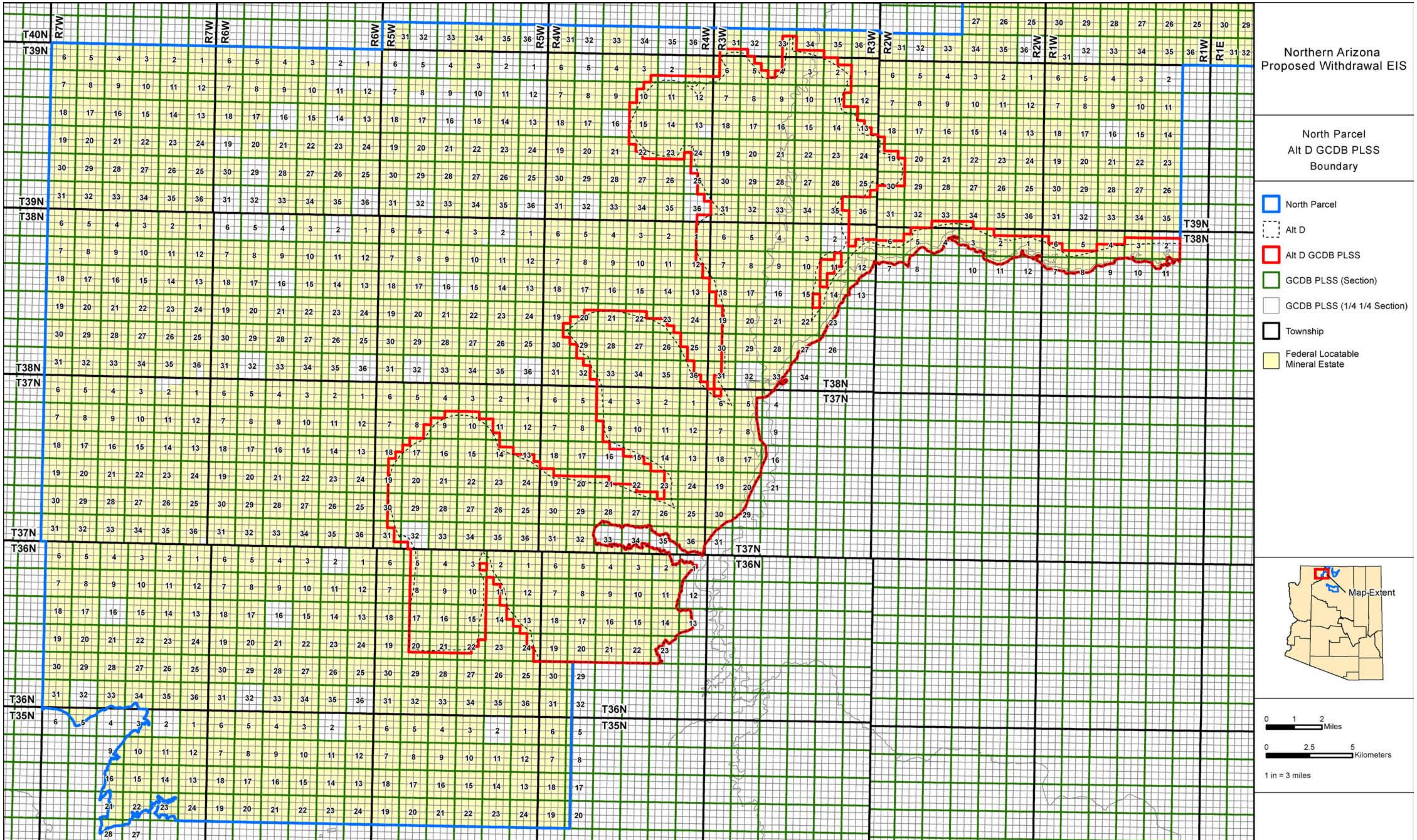

Northern Arizona Proposed Withdrawal EIS
South Parcel
ALT D GCDB PLSS
Boundary
South Parcel
Alt D
Alt D GCDB PLSS
GCDB PLSS (Section)
GCDB PLSS (1/4 1/4 Section)
Township
Federal Locatable Mineral Estate
Map Extent
0 1 2 Miles
0 2.5 5 Kilometers
1 in = 3 miles
T32N
T31N
T30N
T29N
T28N
T27N
R1W
R1E
R2E
R3E
R4E
R5E
R6E


Northern Arizona Proposed Withdrawal EIS
North Parcel Alt D GCDB PLSS Boundary
North Parcel
Alt D
Alt D GCDB PLSS
GCDB PLSS (Section)
GCDB PLSS (1/4 1/4 Section)
Township
Federal Locatable Mineral Estate
Map Extent
Miles
Kilometers
1 in = 3 miles


Northern Arizona
Proposed Withdrawal EIS
East Parcel
Alt D GCDB PLSS
Boundary
East Parcel
Alt D
Alt D GCDB PLSS
GCDB PLSS (Section)
GCDB PLSS (1/4 1/4 Section)
Township
Federal Locatable
Mineral Estate
Map Extent
0 1 2 Miles
0 2.5 5 Kilometers
1 in = 3 miles
T40N
T39N
T38N
T37N
T36N
R3E
R4E
R5E
R6E
R7E

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Appendix D

SUMMARY OF RECORDS FOR SELECTED WELLS

Table D-1. Summary of Records for Selected Wells

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1	A(25-02) 27ABA	Wells 35	7866	394,499	3,931,996	01-Jan-69	3,670		2,880				7				2,838	28	IND	PROD			
1	A(25-02) 27BAC	Wells 55	601192	393,895	3,931,803	10-Jan-70	3,685		3,324				7			2,770			PROD	IND	Black Mesa Pipeline,		
1	A(25-02) 27ABB	GWSI	353134112094901	394,259	3,932,046	01-Dec-69	3,675		3,324	3,324	3,670	3,670	7	6,158	1-Dec-69	2,838	3,320	28	W	IND	Black Mesa Pipeline Co.		G
1	A(25-02) 27ABB	GWSI	353134112094901	394,259	3,932,046	01-Dec-69	3,675		3,324	2,880	3,050	3,670	7	6,158	1-Dec-69	2,838	3,320	28	W	IND	Black Mesa Pipeline Co.		G
1	A(25-2) BA	AOGC		394,479	3,931,986	01-Dec-69	3,685							6,165						WW	Black Mesa Pipe.		
3	A(25-06) 29	GWSI	353110111462001	429,916	3,930,925		730			630		730	8	7,100				4	U	U		Y	D
4	A(25-06) 29	Wells 35	7872	429,801	3,931,019		730						8					4	K	X		Y	
5	A(25-09) 06CCA	Wells 35	7875	456,479	3,936,501	01-Jan-66	1,788		1,780				8			1,583		18	M	PROD			
5	A(25-09) 06CCA	Wells 55	649814	456,479	3,936,501	25-Jan-67	1,788		1,780				8			1,584		18	PROD	M	NPS		
5	A(25-09) 06CCD	GWSI	353410111284001	456,491	3,936,363	01-Dec-66	1,800	3	1,788	1,780	1,788	1,788	8	5,381	8-Apr-04	1,588	3,793	17.6	U	U	NPS	Y	D
6	A(25-10) 30BCA	Wells 55	649816	466,107	3,930,822	22-Nov-61	904		904				10			781		16	PROD	M	NPS		
6	A(25-10) 30BCA	Wells 35	7876	466,107	3,930,822	01-Jan-58	904		904				10			781		50	M	PROD			
6	A(25-10) 30BDB	GWSI	353110111221001	466,237	3,930,776	01-Oct-58	904		800	800	904	904	10	4,930	5-Jun-01	779	4,151	50	W	D	NPS		D
8	A(26-02) 01CDD	Wells 55	545765	397,569	3,946,652	28-Dec-94	3,200		2,630				13	6,005		2,500	3,505	41	PROD	D	Grand Canyon Equip,		
9	A(26-02) 02DAD	GWSI	353845112082201	396,780	3,945,265	01-Jan-37	1,800					1,800	10	5,980	14-Jun-84	1,414	4,566		U	U	Robidoux	Y	
10	A(26-02) 11AAD	Wells 35	7884	396,761	3,946,257	01-Jan-37	1,800						8			1,600		1		X		Y	
11	A(26-02) 11CDD	GWSI	353839112085901	395,847	3,945,092		1,190					1,190	8	5,990					U	U	Robidoux	Y	
12	A(26-02) 11DDB	GWSI	353843112083301	396,503	3,945,207	15-Jun-94	3,450		25	2,602	3,450	3,450	13	5,999					W	MUN			D
12	A(26-02) 11DDC	Wells 55	543573	396,550	3,945,057	15-Jun-94	3,450		2,602				13			2,550		85	PROD	M	Hydro Resources Inc		
13	A(26-03) 01AAB	Wells 55	536393	407,871	3,947,947	08-Sep-92	250												PROD	D	Wingfield, Louis,		
14	A(26-03) 02	Wells 55	514075	405,754	3,947,265	01-May-86													X	NONE	Uranerz USA Inc,	Y	
15	A(26-03) 02D	Wells 55	518030	406,162	3,946,859														ME	NONE	Uranerz USA Inc.,	Y	
16	A(26-03) 06DBC	Wells 55	555659	399,401	3,947,040		2,340		250				10	5,980		1,380	4,600		PROD	C	Collins	N	
17	A(26-05) 19DDD	Wells 55	613909	419,197	3,941,610	01-Jan-40	1,500						8						PROD	S	C O Bar Livestock,		
18	A(26-08) 01BC	Wells 35	7885	454,835	3,946,871	01-Jan-57	1,550								14-Jan-04			15	D	PROD			
18	A(26-08) 01BCA	GWSI	354000111295001	454,909	3,946,877	23-Feb-57	1,550					1,550	8	5,205	23-Feb-57	1,475	3,730		W	D	C O Bar Livestock		D
18	A(26-08) 01BCD	Wells 55	613905	454,934	3,946,771	01-Feb-57	1,550						8			1,475		15	PROD	D	C O Bar Livestock,		
19	A(26-08) 35ADB	Wells 55	613910	454,288	3,938,924	01-Jan-25	1,662						8			1,580			PROD	S	C O Bar Livestock,		
19	A(26-08) 35CBD	GWSI	353517111305401	453,280	3,938,382	01-Jan-25	1,662					1,662	8	5,450	1-Jan-54	1,500	3,950		X	U	C O Bar Livestock	Y	D
20	A(26-08) 36BC	Wells 35	7886	454,789	3,938,821	01-Jan-25	1,662						8			1,500			K	X		Y	
21	A(26-09) 15AC	Wells 35	7887	462,035	3,943,609		1,250		14				6			1,152			S	PROD			
22	A(26-09) 15DAD	Wells 55	613907	462,535	3,943,102	01-Jan-52	1,250						8			1,152		15	PROD	S	C O Bar Livestock,		
22	A(26-09) 15DAD	GWSI	353817111251001	462,612	3,943,175		1,250		14	14	1,250	1,250	6	5,075	14-Feb-67	1,152	3,923	18	W	S	C O Bar Livestock		D
23	A(26-09) 33CAD	GWSI	353520111260001	460,175	3,938,195	01-Jan-52	1,440					1,440	8	5,335	22-Oct-54	1,343	3,992	15	W	S	C O Bar Livestock		D
23	A(26-09) 33CAD	Wells 55	613906	460,101	3,938,286	01-Jan-52	1,440						8			1,343		15	PROD	S	C O Bar Livestock,		
23	A(26-09) 33DAC	Wells 35	7888	460,705	3,938,281	01-Jan-52	1,440						8			1,343		15	S	PROD			
24	A(26-10) 31CA	Wells 35	7891	466,436	3,938,344	01-Jan-50	1,009						8			927		12	S	PROD			
25	A(26-10) 31CBA	GWSI	353523111222701	466,040	3,938,509	01-Jan-50	1,009					1,009	8	5,062	5-Jun-01	927	4,136	12	W	D	C O Bar Livestock		D
25	A(26-10) 31CBB	Wells 55	613908	465,931	3,938,443	01-Jan-50	1,009						8			927		15	PROD	S	C O Bar Livestock,		
26	A(27-01) 01	Wells 55	515267	388,278	3,957,192	04-Oct-86	1,800												X	NONE	Uranerz U.S.A. Inc,	Y	
27	A(27-01) 02C	Wells 55	514076	386,263	3,956,797	20-May-86	1,365		5										X	NONE	Uranerz, USA Inc,	Y	
28	A(27-01) 11	Wells 55	513922	386,653	3,955,566	01-Nov-86													X	NONE	Uranerz U.S.A., Inc,	Y	
29	A(27-01) 12B	Wells 55	514636	387,861	3,955,982														ME	NONE	Uranerz U.S.A. Inc,	Y	
30	A(27-02) 13AAA	Wells 55	511493	398,654	3,954,498	25-Jul-85	1,100						8						PROD	D	Maes,D		
31	A(27-02) 16B	Wells 55	510564	392,709	3,954,256														ME	NONE	Pathfinder Mines Crp,	Y	
32	A(27-03) 01BB0	Wells 55	524857	407,006	3,957,513	09-Jul-89	140						5						X	NONE	Energy Fuels Nuclear,	Y	
33	A(27-03) 07BDD	Wells 55	546799	399,458	3,955,516														PROD	D	Barbie Drilling, Inc,		
34	A(27-03) 07BDD	Wells 55	553128	399,458	3,955,516														PROD	D	Karr, Ranger,	Y	
35	A(27-03) 07BDD	Wells 55	563478	399,458	3,955,516														PROD	D	Karr, Ranger,	Y	
36	A(27-03) 34BBB	Wells 55	583845	403,596	3,949,628														PROD	D	Wingfield	Y	
37	A(27-04) 05A	Wells 55	518002	411,181	3,957,282	24-Aug-87	170						5						ME	NONE	Energy Fuels Expl,	Y	
38	A(27-04) 06	Wells 55	529008	409,192	3,956,885	01-Sep-90													ME	NONE	Red Butte Joint Vent,		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
39	A(27-04) 06	Wells 55	532733	409,192	3,956,885	30-Sep-91													ME	NONE	Dir Exploration Inc,		
40	A(27-04) 06	Wells 55	536177	409,192	3,956,885	30-Oct-92													ME	NONE	Dir Exploration Inc,	Y	
41	A(27-04) 12	Wells 55	515016	417,224	3,955,218														ME	NONE	Pathfinder Mines Crp,	Y	
42	A(27-04) 13	Wells 55	520746	417,209	3,953,596														ME	NONE	Pathfinder Mines Crp,	Y	
43	A(27-04) 13BBB	GWSI	354345111551901	416,558	3,954,302									6,455					W	OTHER			
44	A(27-04) 13BBB	Wells 55	613895	416,504	3,954,312	01-Jan-42	1,600						8						PROD	S	C O Bar Livestock,		
45	A(27-04) 13BBB	Wells 35	7898	416,504	3,954,312								12						K	WD			
46	A(27-04) 18	Wells 55	507952	409,169	3,953,669	08-Aug-84													X	NONE	Rocky Mtn Energy,	Y	
47	A(27-04) 18	Wells 55	520202	409,169	3,953,669														ME	NONE	Union Pacific,	Y	
48	A(27-04) 23CDD	Wells 55	613896	415,480	3,951,298	01-Jan-48	2,245						8						PROD	S	C O Bar Livestock,		
48	A(27-04) 23DCC	GWSI	354206111555601	415,600	3,951,260		2,250					2,250		6,415					W	OTHER	C O Bar Livestock Co		
48	A(27-04) 23DCC	Wells 35	7899	415,683	3,951,295		2,250												K	X		Y	
49	A(27-05) 01	Wells 55	520745	426,896	3,956,791														ME	NONE	Pathfinder Mines Crp,	Y	
50	A(27-05) 02BB0	Wells 55	524862	424,672	3,957,420	13-Jul-89	60						5						X	NONE	Energy Fuels Nuclear,	Y	
51	A(27-05) 05	Wells 55	217272	420,444	3,956,835																Vane Minerals (U.S) LLC		
52	A(27-05) 05C	Wells 55	512212	420,046	3,956,430														ME	NONE	Energy Fuels Expl,	Y	
53	A(27-05) 05C	Wells 55	513370	420,046	3,956,430	12-Jun-86			150				6						X	NONE	Energy Fuels Expl,	Y	
54	A(27-05) 05D	Wells 55	512211	420,855	3,956,432														ME	NONE	Energy Fuels Expl,	Y	
55	A(27-05) 05D	Wells 55	513371	420,855	3,956,432	12-Jun-86			150				6						X	NONE	Energy Fuels Expl,	Y	
56	A(27-05) 06	Wells 55	511386	418,835	3,956,833														ME	NONE	Rocky Mtn Energy,	Y	
57	A(27-05) 06A	Wells 55	515020	419,232	3,957,234	23-Sep-86	45						5						X	NONE	Energy Fuels Expl,	Y	
58	A(27-06) 04AA	Wells 55	524864	432,297	3,957,344	15-Jul-89	80						5						X	NONE	Energy Fuels Nuclear,	Y	
59	A(27-06) 21	Wells 55	521803	431,662	3,951,860	19-Aug-88	60						5						ME	NONE	Energy Fuels Expl,	Y	
60	A(27-07) 23B	GWSI	354233111371001	443,902	3,951,869	19-Nov-51	300					300		5,400					U	U	Navajo	Y	
61	A(27-07) 26A	GWSI	354202111365401	444,298	3,950,911	15-Dec-51	133					133		5,420					U	U	Navajo	Y	
62	A(27-09) 06AAD	Wells 55	804657	457,761	3,956,824	15-Aug-71	1,500		1,480				6			1,260		8	PROD	D	Flagstaff Mission,		
62	A(27-09) 06AAD	GWSI	354517111275901	457,772	3,956,844	01-Jan-71	1,500					1,500	6	4,960	6-Jan-72	1,215	3,745		W	D	Navajo Flagstaff Mission		
63	A(27-09) 06ADB	GWSI	354510111280101	457,570	3,956,537	28-Sep-78	1,600	2	1,600	1,291	1,600	1,600	8.62	5,000	28-Sep-78	1,236	3,764	37	W	MUN	ASLD		G
63	A(27-09) 06ADC	Wells 35	7900	457,564	3,956,424	28-Sep-78	1,600		1,602	1,291	1,600		8			1,236			D	PROD	AZ Dept of Trans		
63	A(27-09) 06ADC	Wells 55	628106	457,564	3,956,424	28-Sep-78	1,600		1,600				8			1,236		35	PROD	D	ASLD		
64	A(27-09) 06D	Wells 55	608333	457,465	3,955,922		1,550						8			1,200		10	PROD	D	Thriftway Mrkt Corp,		
65	A(27-09) 06D	Wells 55	608334	457,465	3,955,922		1,500						8			1,200		20	PROD	D	Thriftway Mrkt Corp,		
66	A(27-09) 06DC	Wells 35	7901	457,268	3,955,722	01-Jan-64	1,500						8			1,308		20	M	PROD			
66	A(27-09) 06DCA	GWSI	354440111282001	457,415	3,955,706	01-Jan-64	1,500					1,500	8	5,030	12-May-66	1,308	3,722	20	W	MUN	Thriftway Marketing Corp		
67	A(27-09) 06DCA	GWSI	354442111281501	457,365	3,955,768	01-Sep-55	1,408	2				1,408	8	5,030	30-Sep-55	1,250	3,780	6	W	MUN	Thriftway Marketing Corp		D
68	A(27-09) 07ABB	GWSI	354430111282701	457,062	3,955,400	11-Mar-77	1,500		196	196	1500	1,500	8.62	5,035	11-Mar-77	1,325	3,710		W	IND	Thriftway Marketing Corp		D
69	A(27-09) 07ABB	Wells 55	600260	457,169	3,955,422	01-Jan-60	1,500		35				8			1,200		18	PROD	IND	Thriftway Mrkt Corp,		
70	A(27-09) 07ABB	Wells 55	600261	457,169	3,955,422	30-Jun-76	1,600		40				8			1,200		18	PROD	IND	Thriftway Mrkt Corp,		
71	A(27-09) 07ABB	Wells 35	7902	457,169	3,955,422	01-Jan-58	1,613											25	M	PROD			
72	A(27-09) 07ABB	Wells 35	7903	457,169	3,955,422	11-Mar-77	1,500		196				8			1,325		15	D	PROD	Whiting Bros Oil Co		
73	A(27-09) 07ABB	GWSI	354420111282001	456,861	3,955,432		1,613					1,613		5,040					U	U	Thriftway Marketing Corp	Y	
74	A(27-09) 07BAA	GWSI	354421111282101	457,211	3,955,122	01-Jan-67	1,450			270	1,450	1,450	8	5,040	1-Feb-67	1,150	3,890		W	D	Toto Traders		D
74	A(27-09) 07BAA	Wells 35	7904	456,973	3,955,423	26-Feb-67	1,450		270				8			250		9	D	PROD	Pickens Myers Co		
74	A(27-09) 07BAD	Wells 55	620560	456,972	3,955,221		1,450		150				8			1,150		32	PROD	IND	Toto Traders Inc an AZ Corp		
75	A(27-09) 11DDD	Wells 55	613901	464,196	3,953,960	01-Jan-66	750						6			706		8	PROD	S	C O Bar Livestock,		
75	A(27-09) 11DDD	GWSI	354350111235001	464,165	3,954,013		750					750		4,501	10-Nov-66	707	3,794	7	W	S	C O Bar Livestock		
76	A(27-09) 15CCC	Wells 35	7906	461,160	3,952,375	01-Jan-48	2,165						12			1,315			S	PROD			
76	A(27-09) 15CCC	Wells 55	613899	461,160	3,952,375	01-Apr-48	2,165						12			1,315		8	PROD	S	C O Bar Livestock,		
76	A(27-09) 15CCC	GWSI	354257111254001	461,244	3,952,515	01-Apr-48	2,165					2,165	12	5,093	5-Oct-66	1,315	3,778		W	S	C O Bar Livestock		G
77	A(27-09) 21AAA	Wells 55	613900	460,958	3,952,175	01-Feb-49	3,624						12					8	PROD	S	C O Bar Livestock,		
77	A(27-09) 21AAA	Wells 35	7906	460,958	3,952,175	01-Jan-49	3,624						12			1,309			K	X		Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
77	A(27-09) 21ABD	GWSI	354240111260701	460,563	3,951,995	01-Feb-49	3,624					3,624	12	5,090	5-Oct-66	1,309	3,781		X	U	C O Bar Livestock	Y	G
78	A(27-09) 29BDC	Wells 55	578918	458,336	3,949,978	18-Dec-00	1,712		1,712				10			1,426			PROD	MIN	United Metro Materials Inc		
79	A(27-9) AA	AOGC		460,856	3,952,069	01-Feb-49	3,624							5,096						DH	Lockhart, L.M.		
80	A(27-9) CB	AOGC		461,264	3,953,276	01-Dec-03	4,350							5,068						DH	Clayton Williams		
81	A(27-9) CC	AOGC		461,268	3,952,486	01-Jul-48	2,165							5,093						DH	Barron-Steele		
82	A(28-01) 03	Wells 55	216768	385,176	3,966,865		10						10						ME	ME	Vane Minerals Group		
83	A(28-01) 15	Wells 55	521804	385,129	3,963,652	19-Aug-88	150						5						ME	NONE	Energy Fuels Expl,	Y	
84	A(28-01) 15B	Wells 55	509254	384,733	3,964,058														ME	NONE	Energy Fuels Expl,	Y	
85	A(28-01) 23	Wells 55	513921	386,717	3,962,022	01-Nov-86	400						6						X	NONE	Uranerz U.S.A, Inc,	Y	
86	A(28-01) 23	Wells 55	518000	386,717	3,962,022	02-Jun-87	160						5						ME	NONE	Uranerz USA Inc.,	Y	
87	A(28-01) 24	Wells 55	518001	388,340	3,962,007	02-Jun-87	180						5						ME	NONE	Uramerz USA Inc,	Y	
88	A(28-01) 24BBB	Wells 55	512999	387,633	3,962,712	23-Sep-85													X	NONE	Uranerz USA Inc,	Y	
89	A(28-01) 24C	Wells 55	514637	387,925	3,961,608														ME	NONE	Uranerz, USA Inc,	Y	
90	A(28-01) 25AAA	Wells 55	512998	389,038	3,961,099	11-Sep-85			761				4						X	NONE	ASLD	Y	
91	A(28-01) 26	Wells 55	509036	386,702	3,960,416														ME	NONE	Rocky Mtn Energy,	Y	
92	A(28-01) 28	Wells 55	515984	383,478	3,960,444														ME	NONE	Energy Fuels Expl,	Y	
93	A(28-01) 32A	Wells 55	515029	382,255	3,959,246	30-Sep-86	150						5						X	NONE	Energy Fuels Expl,	Y	
94	A(28-01) 33A	Wells 55	515990	383,868	3,959,231														ME	NONE	Energy Fuels Expl,	Y	
95	A(28-02) 03A	Wells 55	510840	395,251	3,967,136		200						5						X	NONE	Energy Fuels Expl,	Y	
96	A(28-02) 03ABA	Wells 55	508119	395,152	3,967,439														ME	NONE	Energy Fuels Expl,	Y	
97	A(28-02) 03D00	Wells 55	521302	395,252	3,966,331	24-Jul-88	150						5						ME	NONE	Energy Fuels Expl,	Y	
98	A(28-02) 06	Wells 55	517573	390,025	3,966,806														ME	NONE	Uranerz USA, Inc,	Y	
99	A(28-02) 06B00	Wells 55	520640	389,623	3,967,212														ME	NONE	Uranerz, U.S.A. Inc,	Y	
100	A(28-02) 11AC	Wells 55	524855	396,650	3,965,325	08-Jul-89	100						5						X	NONE	Energy Fuels Nuclear,	Y	
101	A(28-02) 11B	Wells 55	510906	396,050	3,965,526		150						5						X	NONE	Energy Fuels Expl,	Y	
102	A(28-02) 11BB	Wells 55	508118	395,852	3,965,726														ME	NONE	Energy Fuels Expl,	Y	
103	A(28-02) 14CC	Wells 55	507759	395,821	3,962,917	19-Jun-84													ME	NONE	Pathfinder Mines Crp,	Y	
104	A(28-02) 17	Wells 55	511392	391,613	3,963,567														X	NONE	Uranerz U S A Inc,	Y	
105	A(28-02) 17	Wells 55	517575	391,613	3,963,567	23-Apr-87	450						5						ME	NONE	Uranerz USA, Inc.,	Y	
106	A(28-02) 17AAB	Wells 55	513920	392,123	3,964,260	01-Nov-86	1,461		6										X	NONE	Uranerz U.S.A., Inc,	Y	
107	A(28-02) 18	Wells 55	517574	390,002	3,963,590														ME	NONE	Uranerz USA, Inc.,	Y	
108	A(28-02) 19	Wells 55	517571	389,971	3,961,988														ME	NONE	Uramerz USA, Inc.,	Y	
109	A(28-02) 19CCA	Wells 55	508374	389,453	3,961,495	14-Jun-84	405						3						ME	NONE	ASLD	Y	
110	A(28-02) 20	Wells 55	517576	391,590	3,961,962	04-Jun-87	20												ME	NONE	Uranerz USA, Inc,	Y	
111	A(28-02) 21C	Wells 55	512252	392,792	3,961,544														X	NONE	Energy Fuels Expl,	Y	
112	A(28-02) 22BBB	Wells 55	514362	394,112	3,962,629	01-Nov-86	1,295		5										X	NONE	Uranerz U.S.A. Inc,	Y	
113	A(28-02) 29A	Wells 55	517577	391,979	3,960,752	21-Apr-87	220						5						ME	NONE	Uranerz USA, Inc.,	Y	
114	A(28-02) 29BCB	GWSI	354704112122801	390,782	3,960,713									5,983					U	U		Y	
115	A(28-02) 30	Wells 55	520647	389,946	3,960,381														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
116	A(28-02) 32	Wells 55	216769	391,553	3,958,748		10						10						ME	ME	Vane Minerals Group		
117	A(28-02) 33	Wells 55	515268	393,165	3,958,724	02-Oct-86	21						5						X	NONE	Energy Fuels Expl,	Y	
118	A(28-02) 34B	Wells 55	515031	394,380	3,959,112	02-Oct-86	21						5						X	NONE	Energy Fuels Expl,	Y	
119	A(28-03) 03	Wells 55	519482	404,470	3,966,627														ME	NONE	Energy Fuels Expl,	Y	
120	A(28-03) 04	Wells 55	509301	402,857	3,966,645	08-Jan-85													ME	NONE	Energy Fuels Expl,	Y	
121	A(28-03) 04B	Wells 55	512156	402,450	3,967,054														ME	NONE	Energy Fuels Expl,	Y	
122	A(28-03) 04B	Wells 55	513368	402,450	3,967,054														ME	NONE	Energy Fuels Expl,	Y	
123	A(28-03) 04B	Wells 55	528710	402,450	3,967,054	16-Sep-92	800												ME	NONE	Energy Fuels Nuclear,		
124	A(28-03) 04BA	Wells 55	519480	402,650	3,967,254														ME	NONE	Energy Fuels Expl,	Y	
125	A(28-03) 04BC0	Wells 55	519479	402,250	3,966,853														ME	NONE	Energy Fuels Expl,	Y	
126	A(28-03) 06	Wells 55	517651	399,645	3,966,687		1,471						5						ME	NONE	Energy Fuels Expl,	Y	
127	A(28-03) 06B	Wells 55	510078	399,246	3,967,095	29-Apr-85	1,655						5						X	NONE	Energy Fuels Expl,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
128	A(28-03) 06BD	Wells 55	513697	399,446	3,966,892														ME	NONE	Energy Fuels Expl,	Y	
129	A(28-03) 06BD0	Wells 55	508124	399,446	3,966,892	19-Jul-84													ME	NONE	Energy Fuels Expl,	Y	
130	A(28-03) 07BAA	Wells 55	508356	399,546	3,965,785	05-Dec-84													ME	NONE	Energy Fuels Expl,	Y	
131	A(28-03) 10	Wells 55	529005	404,454	3,965,004	01-Sep-90													ME	NONE	Red Butte Joint Vent,		
132	A(28-03) 10A	Wells 55	536179	404,862	3,965,403	30-Oct-92													ME	NONE	Dir Exploration Inc,	Y	
133	A(28-03) 12	Wells 55	529007	407,661	3,964,978	01-Sep-90													ME	NONE	Red Butte Joint Vent,		
134	A(28-03) 12	Wells 55	536176	407,661	3,964,978	30-Oct-92													ME	NONE	Dir Exploration Inc,	Y	
135	A(28-03) 14	Wells 55	520642	406,041	3,963,372														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
136	A(28-03) 18	Wells 55	507754	399,609	3,963,469	16-Jun-84													ME	NONE	Pathfinder Mines Crp,	Y	
137	A(28-03) 23	Wells 55	510563	406,032	3,961,758														ME	NONE	Pathfinder Mines Crp,	Y	
138	A(28-03) 23CC	Wells 55	507763	405,420	3,961,162	16-Jun-84													ME	NONE	Pathfinder Mines Crp,	Y	
139	A(28-03) 26	Wells 55	507760	406,014	3,960,148	17-Jun-84													ME	NONE	Pathfinder Mines Crp,	Y	
140	A(28-03) 30DAA	Wells 55	507923	400,270	3,960,143	18-Jun-84													ME	NONE	Pahtfinder Mines,	Y	
141	A(28-03) 36DA	Wells 55	507755	408,219	3,958,296	16-Jun-84													ME	NONE	Pathfinder Mines Crp,	Y	
142	A(28-04) 05CD	Wells 55	516075	410,645	3,965,979														ME	NONE	Energy Fuels Expl,	Y	
143	A(28-04) 05CD	Wells 55	519525	410,645	3,965,979	15-Dec-87													ME	NONE	Energy Fuels Expl,		
144	A(28-04) 07D	Wells 55	518004	409,640	3,964,587	24-Aug-87	200						5						ME	NONE	Energy Fuels Expl,	Y	
145	A(28-04) 08A	Wells 55	518005	411,249	3,965,369	24-Aug-87	200						5						ME	NONE	Energy Fuels Expl,	Y	
146	A(28-04) 08AB	Wells 55	508113	411,045	3,965,573	26-Aug-84													ME	NONE	Energy Fuels Expl,	Y	
147	A(28-04) 10	Wells 55	510566	414,069	3,964,931														ME	NONE	Pathfinder Mines Crp,	Y	
148	A(28-04) 11	Wells 55	217276	415,693	3,964,921																Vane Minerals (U.S.) LLC		
149	A(28-04) 11A	Wells 55	521298	416,100	3,965,323	29-Jul-88	160						5						ME	NONE	Energy Fuels Expl,	Y	
150	A(28-04) 11CA	Wells 55	535753	415,486	3,964,722	10-Sep-92													ME	NONE	Energy Fuels Nuclear,		
151	A(28-04) 11DA	Wells 55	509272	416,293	3,964,719	05-Dec-84													ME	NONE	Energy Fuels Expl,	Y	
152	A(28-04) 11DA	Wells 55	528698	416,293	3,964,719	8/8/1990 12:00:00 AM													X	NONE	Energy Fuels Nuclear,	Y	
153	A(28-04) 12	Wells 55	217274	417,310	3,964,927																Vane Minerals (U.S.) LLC		
154	A(28-04) 12	Wells 55	511385	417,310	3,964,927														ME	NONE	Rocky Mtn Energy,	Y	
155	A(28-04) 12	Wells 55	515162	417,310	3,964,927	05-Oct-86	1,235						5						X	NONE	Rocky Mtn Energy,	Y	
156	A(28-04) 12	Wells 55	520254	417,310	3,964,927														ME	NONE	Union Pacific,	Y	
157	A(28-04) 12	Wells 55	524448	417,310	3,964,927	22-May-89													ME	NONE	Red Butte Joint Vent,		
158	A(28-04) 13	Wells 55	511891	417,291	3,963,301		993						5						X	NONE	Rocky Mtn Energy,	Y	
159	A(28-04) 17D	Wells 55	509266	411,219	3,962,943														ME	NONE	Energy Fuels Expl,	Y	
160	A(28-04) 17D	Wells 55	510841	411,219	3,962,943	09-May-85													ME	NONE	Energy Fuels Expl,	Y	
161	A(28-04) 19DCB	Wells 55	613897	409,306	3,961,226		1,200						8						PROD	S	C O Bar Livestock,		
162	A(28-04) 19DCB	Wells 55	613898	409,306	3,961,226	01-Jan-25	40									39		2	PROD	D	C O Bar Livestock,		
163	A(28-04) 21	Wells 55	507761	412,421	3,961,732														ME	NONE	Pathfinder Mines Crp,	Y	
164	A(28-04) 21C	Wells 55	521300	412,009	3,961,327	29-Jul-88	200						5						ME	NONE	Energy Fuels Expl,	Y	
165	A(28-04) 21CC	Wells 55	528700	411,806	3,961,126	15-May-92	300												ME	NONE	Energy Furls Nuclear,		
166	A(28-04) 24C	Wells 55	509271	416,864	3,961,282	28-Nov-84													ME	NONE	Energy Fuels Expl,	Y	
167	A(28-04) 26	Wells 55	511760	415,643	3,960,079	01-Sep-85													X	NONE	Pathfinder Mines Crp,	Y	
168	A(28-05) 03BD0	Wells 55	524858	423,545	3,966,681	14-Jul-89	100						5						X	NONE	Energy Fuels Nuclear,	Y	
169	A(28-05) 11	Wells 55	513804	425,317	3,964,888	10-Nov-86	1,340						5						X	NONE	Pathfinder Mines Crp,	Y	
170	A(28-05) 11	Wells 55	520749	425,317	3,964,888														ME	NONE	Pathfinder Mines Crp,	Y	
171	A(28-05) 12	Wells 55	513803	426,942	3,964,875														ME	NONE	Pathfinder Mines Crp,	Y	
172	A(28-05) 13	Wells 55	510568	426,926	3,963,261	01-Sep-85													X	NONE	Pathfinder Mines Crp,	Y	
173	A(28-05) 13	Wells 55	513802	426,926	3,963,261	10-Nov-86	2,600						5						X	NONE	Pathfinder Mines Crp,	Y	
174	A(28-05) 13	Wells 55	517450	426,926	3,963,261	14-Dec-87	2,140		6										ME	NONE	Pathfinder Mines Crp,	Y	
175	A(28-05) 13	Wells 55	520748	426,926	3,963,261	30-Jun-88													ME	NONE	Pathfinder Mines Crp,	Y	
176	A(28-05) 14	Wells 55	217275	425,322	3,963,268																Vane Minerals (U.S.) LLC		
177	A(28-05) 15CC	Wells 55	524859	423,116	3,962,666														ME	NONE	Energy Fuels Nuclear,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
178	A(28-05) 20B	Wells 55	520641	420,068	3,962,070	01-May-88	140						5						ME	NONE	Uranerz, U.S.A. Inc.,	Y	
179	A(28-05) 25A	Wells 55	513361	427,326	3,960,429														ME	NONE	Engery Fuels Expl,	Y	
180	A(28-05) 25AC	Wells 55	509270	427,122	3,960,234														ME	NONE	Energy Fuels Expl,	Y	
181	A(28-05) 25AC	Wells 55	510795	427,122	3,960,234	10-May-85													ME	NONE	Energy Fuels Expl,	Y	
182	A(28-05) 25AC	Wells 55	528699	427,122	3,960,234	12-Aug-90													ME	NONE	Energy Fuels Nuclear,	Y	
183	A(28-05) 27CD	Wells 55	509269	423,491	3,959,442														ME	NONE	Energy Fuels Expl,	Y	
184	A(28-05) 27CD	Wells 55	510615	423,491	3,959,442	06-May-85													ME	NONE	Energy Fuels Expl,	Y	
185	A(28-05) 29AB	Wells 55	515019	420,668	3,960,653	02-Oct-86													X	NONE	Energy Fuels Expl,	Y	
186	A(28-05) 29D	Wells 55	515021	420,864	3,959,652	23-Sep-86	45						5						X	NONE	Energy Fuels Expl,	Y	
187	A(28-05) 30D	Wells 55	515017	419,253	3,959,657														ME	NONE	Energy Fuels Expl,	Y	
188	A(28-05) 32B	Wells 55	515018	420,045	3,958,850														ME	NONE	Energy Fuels Expl,	Y	
189	A(28-05) 32BD	Wells 55	524860	420,244	3,958,649	08-Jul-89	100						5						X	NONE	Energy Fuels Nuclear,	Y	
190	A(28-05) 32D	Wells 55	512210	420,837	3,958,051														ME	NONE	Energy Fuels Expl,	Y	
191	A(28-05) 32D	Wells 55	513372	420,837	3,958,051	12-Jun-86			150				6						X	NONE	Energy Fuels Expl,	Y	
192	A(28-05) 33AA	Wells 55	524861	422,670	3,959,042	13-Jul-89	120						5						X	NONE	Energy Fuels Nuclear,	Y	
193	A(28-05) 34C	Wells 55	512213	423,267	3,958,023														ME	NONE	Energy Fuels Expl,	Y	
194	A(28-05) 34C	Wells 55	513373	423,267	3,958,023	12-Jun-86			150				6						X	NONE	Energy Fuels Expl,	Y	
195	A(28-05) 35BA	Wells 55	509267	425,096	3,959,042														ME	NONE	Energy Fuels Expl,	Y	
196	A(28-05) 35BA	Wells 55	510794	425,096	3,959,042		200						5						X	NONE	Energy Fuels Expl,	Y	
197	A(28-05) 36	Wells 55	524863	426,897	3,958,418	13-Jul-89	80						5						X	NONE	Energy Fuels Nuclear,	Y	
198	A(28-05) 36BB	Wells 55	509268	426,289	3,959,052														ME	NONE	Energy Fuels Expl,	Y	
199	A(28-05) 36BB	Wells 55	510616	426,289	3,959,052		200						5						X	NONE	Energy Fuels Expl,	Y	
200	A(28-06) 06B	Wells 55	513992	428,159	3,966,865														ME	NONE	Energy Fuels Expl,	Y	
201	A(28-06) 06B	Wells 55	518709	428,159	3,966,865	15-Oct-87	2,490						5						ME	NONE	Energy Fuels Expl,	Y	
202	A(28-06) 06B	Wells 55	528702	428,159	3,966,865	09-Aug-90													X	NONE	Energy Fuels Nuclear,	Y	
203	A(28-06) 06BD	Wells 55	535752	428,352	3,966,661	04-Sep-92													ME	NONE	Energy Fuels Nuclear,		
204	A(28-06) 09	Wells 55	517650	431,741	3,964,785	11-Sep-87	350		350				6						ME	NONE	Energy Fuels Expl,	Y	
205	A(28-06) 09A	Wells 55	512155	432,148	3,965,183														ME	NONE	Energy Fuels Expl,	Y	
206	A(28-06) 09A	Wells 55	513369	432,148	3,965,183														ME	NONE	Energy Fuels Expl,	Y	
207	A(28-06) 09AC	Wells 55	508121	431,945	3,964,984	17-Aug-84													X	NONE	Energy Fuels Expl,	Y	
208	A(28-06) 09AC	Wells 55	528703	431,945	3,964,984	10-Sep-92													ME	NONE	Energy Fuels Nuclear,		
209	A(28-06) 14	Wells 55	513801	434,944	3,963,159	10-Nov-86	1,703		5										X	NONE	Pathfinder Mines Crp,	Y	
210	A(28-06) 14	Wells 55	520747	434,944	3,963,159														ME	NONE	Pathfinder Mines Crp,	Y	
211	A(28-06) 14BD	Wells 55	524854	434,745	3,963,362	15-Jul-89	100						5						X	NONE	Energy Fuels Nuclear,	Y	
212	A(28-06) 19	Wells 55	521309	428,526	3,961,622	19-Aug-88	200						5						ME	NONE	Energy Fuels Expl,	Y	
213	A(28-06) 19DB	Wells 55	535750	428,723	3,961,418	15-May-92													ME	NONE	Energy Fuels Nuclear,	Y	
214	A(28-06) 20AD	Wells 55	514301	430,712	3,961,782	02-Oct-86	15						5						X	NONE	Energy Fuels Expl,	Y	
215	A(28-06) 20D	Wells 55	508109	430,510	3,961,182	17-Aug-84													X	NONE	Energy Fuels Expl,	Y	
216	A(28-06) 20D	Wells 55	512154	430,510	3,961,182														ME	NONE	Energy Fuels Expl,	Y	
217	A(28-06) 20D	Wells 55	513366	430,510	3,961,182	15-May-86			1,670				6						X	NONE	Energy Fuels Expl,	Y	
218	A(28-06) 21	Wells 55	509037	431,719	3,961,567														ME	NONE	Rocky Mtn Energy,	Y	
219	A(28-06) 21AC	Wells 55	524865	431,922	3,961,767	14-Jul-89	80						5						X	NONE	Energy Fuels Nuclear,	Y	
220	A(28-06) 21CBB	Wells 55	528705	431,011	3,961,474	10-Aug-90													ME	NONE	Energy Fuels Nuclear,	Y	
221	A(28-06) 25C	Wells 55	512157	436,125	3,959,536														ME	NONE	Energy Fuels Expl,	Y	
222	A(28-06) 25C	Wells 55	513367	436,125	3,959,536														ME	NONE	Energy Fuels Expl,	Y	
223	A(28-06) 25CC	Wells 55	508122	435,923	3,959,336	17-Aug-84													X	NONE	Energy Fuels Expl,	Y	
224	A(28-06) 30	Wells 55	528706	428,516	3,960,004	12-Aug-90													X	NONE	Energy Fuels Nuclear,	Y	
225	A(28-06) 30AA	Wells 55	535751	429,115	3,960,603	02-Sep-92													ME	NONE	Energy Fuels Nuclear,	Y	
226	A(28-06) 35A	Wells 55	518007	435,317	3,958,734	25-Aug-87	250						5						ME	NONE	Energy Fuels Expl,	Y	
227	A(28-06) 35AA	Wells 55	528708	435,519	3,958,935	02-Sep-92													ME	NONE	Energy Fuels Nuclear,		
228	A(28-08) 25B	GWSI	354646111294801	455,049	3,959,600	01-May-69	1,292		1,272	1,072	1,272	1,292	8	4,830	22-Feb-04	1,139	3,691	30	W	D	Black Mesa		D
228	A(28-08) 25B	GWSI	354646111294801	455,049	3,959,600	01-May-69	1,292		1,272	1,272	1,292	1,292	8	4,830	22-Feb-04	1,139	3,691	30	W	D	Black Mesa		D

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
229	A(28-08) 25BCD	Wells 55	601191	454,979	3,959,669	12-May-69	1,291		1,093				8			1,062		28	PROD	IND	Black Mesa Pipeline,		
230	A(28-08) 25BCD	Wells 35	7910	454,979	3,959,669	01-Jan-69	1,292		1,072				8			1,062		30	IND	PROD			
231	A(28-08) 36B	GWSI	354605111294701	455,067	3,958,337	01-Jun-58	1,330		1,330			1,330	8.62	4,910	6-Sep-67	1,150	3,760	7	W	D	Navajo		
232	A(28-09) 35B	GWSI	354601111242601	463,127	3,958,176	05-Apr-55	840		630	735	815	815	6.62	4,420	1-Oct-67	690	3,730	6	W	D	Navajo		D
232	A(28-09) 35B	GWSI	354601111242601	463,127	3,958,176	05-Apr-55	840	615	735	735	815	815	5	4,420	1-Oct-67	690	3,730	6	W	D	Navajo		D
233	A(29-01) 27AC	Wells 55	511681	385,465	3,970,280														ME	NONE	Energy Fuels Expl,	Y	
234	A(29-01) 27AC	Wells 55	513744	385,465	3,970,280				2,100				6						ME	NONE	Energy Fuels Expl,	Y	
235	A(29-01) 27ACC	Wells 55	508128	385,363	3,970,181														ME	NONE	Energy Fuels Expl,	Y	
236	A(29-01) 29BAD	Wells 55	613912	381,931	3,970,635	01-Jan-58	1,275												PROD	S	Cataract Livestock,		
237	A(29-01) 29BAD	Wells 55	614367	381,931	3,970,635		150												X		ASLD	Y	
238	A(29-01) 29CD	Wells 55	613911	381,815	3,969,529	01-Jan-58	1,130						8			1,020		5	PROD	S	Cataract Livestock,		
239	A(29-01) 29DBD	Wells 55	614368	382,324	3,969,824	15-Oct-62	1,130						8			1,020		1			ASLD		
240	A(29-01) 30AAD	Wells 55	508126	381,123	3,970,645	13-Jun-84													X	NONE	Energy Fuels Expl,	Y	
241	A(29-02) 01DDA	Wells 55	507757	398,940	3,975,870	17-Jun-84													ME	NONE	Pathfinder Mines Crp,	Y	
242	A(29-02) 10C	Wells 55	521306	394,599	3,974,413	29-Jul-88	150						5						ME	NONE	Energy Fuels Expl,	Y	
243	A(29-02) 10D	Wells 55	508112	395,403	3,974,400	04-Jan-85													ME	NONE	Energy Fuels Expl,	Y	
244	A(29-02) 11	Wells 55	521305	396,614	3,974,782	19-Aug-88	160						5						ME	NONE	Energy Fuels Expl,	Y	
245	A(29-02) 12A	Wells 55	520643	398,630	3,975,167														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
246	A(29-02) 13B	Wells 55	536182	397,807	3,973,554														ME	NONE	Dir Exploration Inc,	Y	
247	A(29-02) 13D	Wells 55	520644	398,606	3,972,745														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
248	A(29-02) 19D	Wells 55	511066	390,512	3,971,225														X	NONE	Uranerz U S A Inc,	Y	
249	A(29-02) 20	Wells 55	507039	391,734	3,971,617														ME	NONE	Rocky Mtn Energy,	Y	
250	A(29-02) 21A	Wells 55	521307	393,759	3,971,998	19-Aug-88	150						5						ME	NONE	Energy Fuels Expl,	Y	
251	A(29-02) 21D	Wells 55	521308	393,752	3,971,191	29-Jul-88	150						5						ME	NONE	Energy Fuels Expl,	Y	
252	A(29-02) 25	Wells 55	508446	398,174	3,969,924	26-Oct-84													ME	NONE	Pathfinder Mines Crp,	Y	
253	A(29-02) 25	Wells 55	511759	398,174	3,969,924	01-Sep-85													X	NONE	Pathfinder Mines Crp,	Y	
254	A(29-02) 25	Wells 55	513800	398,174	3,969,924	10-Nov-86	945						5						X	NONE	Pathfinder Mines Crp,	Y	
255	A(29-02) 25	Wells 55	520744	398,174	3,969,924														ME	NONE	Pathfinder Mines Crp,	Y	
256	A(29-02) 25BB	Wells 55	507756	397,571	3,970,530														ME	NONE	Pathfinder Mines Crp,	Y	
257	A(29-02) 26	Wells 55	508120	396,558	3,969,940														ME	NONE	Energy Fuels Expl,	Y	
258	A(29-02) 26A	Wells 55	521304	396,965	3,970,336														ME	NONE	Energy Fuels Expl,	Y	
259	A(29-02) 27A	Wells 55	511067	395,356	3,970,359		200						5						X	NONE	Energy Fuels Expl,	Y	
260	A(29-02) 29	Wells 55	511885	391,714	3,970,008														ME	NONE	Rocky Mtn Energy,	Y	
261	A(29-02) 31C	Wells 55	520646	389,670	3,968,017														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
262	A(29-02) 34D	Wells 55	521301	395,320	3,967,943	29-Jul-88	150						5						ME	NONE	Energy Fuels Expl,	Y	
263	A(29-02) 34DBB	Wells 55	616514	395,023	3,968,249	01-Jan-68													PROD	D	Hatch, Marvin,R		
264	A(29-02) 35BD	Wells 55	524856	396,339	3,968,536	07-Jul-89	100						5						X	NONE	Energy Fuels Nuclear,	Y	
265	A(29-03) 02B00	Wells 55	518003	405,871	3,976,696	06-Aug-87	200						5						ME	NONE	Energy Fuels Expl,	Y	
265	A(29-03) 06	Wells 55	507038	399,836	3,976,366														X	NONE	Rocky Mtn Energy,	Y	
266	A(29-03) 12	Wells 55	529006	407,869	3,974,674	01-Sep-90													ME	NONE	Red Butte Joint Vent,		
267	A(29-03) 15	Wells 55	536181	404,625	3,973,090														ME	NONE	Dir Exploration Inc,	Y	
268	A(29-03) 19	Wells 55	507758	399,801	3,971,526	17-Jun-84													ME	NONE	Pathfinder Mines Crp,	Y	
269	A(29-03) 20BCD	Wells 55	515772	400,907	3,971,616	02-Dec-86	3,086		2561				8					40	PROD	D	Energy Fuels Nuclear,		
270	A(29-03) 20BD	Wells 55	509470	401,209	3,971,714	14-Dec-84													X	NONE	Energy Fuels Expl,	Y	
271	A(29-03) 20BDC	Wells 55	508003	401,108	3,971,614	20-May-84	2,300												X	NONE	Energy Fuels Expl,	Y	
272	A(29-03) 20BDC	Wells 55	645736	401,108	3,971,614	01-Oct-80	1,580		20				7			140		8	PROD	S	Kaibab Natl Forest,		
273	A(29-03) 20C	Wells 55	509469	401,004	3,971,111	14-Dec-84													ME	NONE	Energy Fuels Expl,	Y	
274	A(29-03) 20CA	Wells 55	542578	401,207	3,971,310	02-Jul-94													ME	NONE	Energy Fuels Nuclear,	Y	
275	A(29-03) 21	Wells 55	508123	403,011	3,971,495	13-Dec-84													ME	NONE	Energy Fuels Expl,	Y	
276	A(29-03) 21	Wells 55	510077	403,011	3,971,495														ME	NONE	Energy Fuels Expl,	Y	
277	A(29-03) 21C	Wells 55	510793	402,609	3,971,095														ME	NONE	Energy Fuels Expl,	Y	
278	A(29-03) 21C	Wells 55	513362	402,609	3,971,095														ME	NONE	Engery Fuels Expl,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
279	A(29-03) 21C	Wells 55	513364	402,609	3,971,095														ME	NONE	Energy Fuels Expl,	Y	
280	A(29-03) 21CC	Wells 55	509466	402,408	3,970,896														ME	NONE	Energy Fuels Expl,	Y	
281	A(29-03) 26	Wells 55	524450	406,218	3,969,848	02-Jun-89													ME	NONE	Red Butte Joint Vent,		
282	A(29-03) 26	Wells 55	532730	406,218	3,969,848	30-Sep-91													ME	NONE	Dir Exploration Inc,		
283	A(29-03) 26A	Wells 55	536178	406,621	3,970,248	30-Oct-92													ME	NONE	Dir Exploration Inc,	Y	
284	A(29-03) 28C	Wells 55	521297	402,594	3,969,478	29-Jul-88													ME	NONE	Energy Fuels Expl,	Y	
285	A(29-03) 28C	Wells 55	528701	402,594	3,969,478	19-Aug-90													X	NONE	Energy Fuels Nuclear,	Y	
286	A(29-03) 28D	Wells 55	511032	403,396	3,969,472		200						5						X	NONE	Energy Fuels Expl,	Y	
287	A(29-03) 30B	Wells 55	536180	399,387	3,970,319	30-Oct-92													ME	NONE	Dir Exploration Inc,	Y	
288	A(29-03) 31	Wells 55	517652	399,761	3,968,297	02-Oct-87	1,903						5						ME	NONE	Energy Fuels Expl,	Y	
289	A(29-03) 31BD	Wells 55	514300	399,564	3,968,502														ME	NONE	Energy Fuels Expl,	Y	
290	A(29-03) 31CD	Wells 55	513698	399,549	3,967,697														ME	NONE	Energy Fuels Expl,	Y	
291	A(29-03) 31CDA	Wells 55	645735	399,652	3,967,796	01-Oct-80	1,560		20				7			160		12	PROD	S	Kaibab Natl Forest,		
292	A(29-03) 33	Wells 55	519483	402,984	3,968,261														ME	NONE	Energy Fuels Expl,	Y	
293	A(29-05) 01A	Wells 55	518006	427,656	3,976,522	15-Oct-87	200						5						ME	NONE	Energy Fuels Expl,	Y	
294	A(29-05) 34	Wells 55	217271	423,972	3,968,089																Vane Minerals (U.S.) LLC		
295	A(29-05) 34	Wells 55	511387	423,972	3,968,089														ME	NONE	Rocky Mtn Energy,	Y	
296	A(29-06) 04	Wells 55	515030	432,077	3,976,099	20-Sep-86													X	NONE	Energy Fuels Expl,	Y	
297	A(29-06) 06BC	Wells 55	508114	428,259	3,976,317	17-Aug-84													X	NONE	Energy Fuels Expl,	Y	
298	A(29-06) 19	Wells 55	510565	428,829	3,971,243														ME	NONE	Pathfinder Mines Crp,	Y	
299	A(29-06) 19C	Wells 55	515024	428,426	3,970,846	23-Sep-86													X	NONE	Energy Fuels Expl,	Y	
300	A(29-06) 32C	Wells 55	518008	429,988	3,967,664	26-Aug-87	100						5						ME	NONE	Energy Fuels Expl,	Y	
301	A(29-06) 33	Wells 55	511902	432,020	3,968,033														ME	NONE	Energy Fuels Expl,	Y	
302	A(29-06) 33	Wells 55	513365	432,020	3,968,033														ME	NONE	Energy Fuels Expl,	Y	
303	A(29-06) 33	Wells 55	528707	432,020	3,968,033	05-Sep-92													ME	NONE	Energy Fuels Nuclear,		
304	A(29-06) 33CB	Wells 55	509467	431,414	3,967,834	03-Jan-85													ME	NONE	Energy Fuels Expl,	Y	
305	A(29-06) 33CB	Wells 55	513993	431,414	3,967,834														ME	NONE	Energy Fuels Expl,	Y	
306	A(29-09) 22D	GWSI	355226111245501	462,449	3,970,040	01-Mar-51	1,012		780	780	1,012	1,012	10	4,240	20-Apr-51	600	3,640	17	U	U	Cameron Tp		D
307	A(29-09) 22D	GWSI	355232111244901	462,601	3,970,225	12-Dec-62	658					658	8	4,210	2-Jan-63	495	3,715	10	W	D	Navajo		
308	A(29-09) 33DAA	GWSI	355101111253901	461,309	3,967,427	01-Jan-64	856		600	600	856	856	6	4,420	27-Nov-67	746	3,674		W	D	Buck Rogers		
308	A(29-09) 33DAA	Wells 35	7915	461,440	3,967,466	01-Jan-64	856						6			746			K	PROD			
309	A(30-01) 02DD	Wells 55	518385	387,655	3,985,579	28-Aug-87	200						5						ME	NONE	Energy Fuels Expl,	Y	
310	A(30-01) 05DAB	Wells 55	578201	382,733	3,986,156														PROD	D	Johnson	Y	
311	A(30-01) 05DAB	Wells 55	579016	382,733	3,986,156														PROD	D	Johnson	Y	
312	A(30-01) 05DDA	Wells 55	616513	382,926	3,985,752	01-Jan-68													PROD	D	Hatch, Marvin,R		
313	A(30-01) 07	Wells 55	521303	380,601	3,984,682	19-Aug-88	150						5						ME	NONE	Energy Fuels Expl,	Y	
314	A(30-01) 17	Wells 55	507040	382,190	3,983,040	03-May-84	130						5						X	NONE	Rocky Mtn Energy,	Y	
315	A(30-01) 17	Wells 55	514829	382,190	3,983,040														ME	NONE	Rocky Mtn Energy,	Y	
316	A(30-01) 18	Wells 55	509038	380,587	3,983,066														ME	NONE	Rocky Mtn Energy,	Y	
317	A(30-01) 18	Wells 55	510849	380,587	3,983,066														ME	NONE	Rocky Mtn Energy,	Y	
318	A(30-01) 18	Wells 55	514830	380,587	3,983,066	08-Sep-86	1,600						5						X	NONE	Rocky Mtn Energy,	Y	
319	A(30-01) 33CC	Wells 55	509468	383,128	3,977,568		170						5						X	NONE	Energy Fuels Expl,	Y	
320	A(30-01) 33D	Wells 55	519481	384,139	3,977,762	28-Nov-87													ME	NONE	Energy Fuels Expl,		
321	A(30-02) 04B	Wells 55	517572	393,113	3,986,509														ME	NONE	Uranerz USA, Inc,	Y	
322	A(30-02) 06	Wells 55	510567	390,288	3,986,141														ME	NONE	Pathfinder Mines Crp,	Y	
323	A(30-02) 08A1	GWSI	355955112115401	391,927	3,984,457	01-Jan-62	547			3		547	8	6,500	1-Jan-72	512	5,988	0.1	U	U		Y	E
324	A(30-02) 08A2	GWSI	355954112115401	391,927	3,984,426	01-Jan-68	733			2		733	5	6,500	1-Oct-68	430	6,070		U	U		Y	E
325	A(30-02) 08AAA	Wells 55	616511	392,621	3,985,197	01-Jan-68													PROD	D	Hatch, Marvin,R		
326	A(30-02) 09D	Wells 55	511068	393,905	3,984,065		200						5						X	NONE	Energy Fuels Expl,	Y	
327	A(30-02) 09DC0	Wells 55	508111	393,702	3,983,868														ME	NONE	Energy Fuels Expl,	Y	
328	A(30-02) 18CDA	Wells 55	616512	390,129	3,982,423	01-Jan-68													PROD	S	Hatch, Marvin,R		
329	A(30-02) 18CDD	Wells 55	579015	390,128	3,982,221														PROD	D	Johnson	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
330	A(30-02) 20ADD	Wells 55	508110	392,561	3,981,381														ME	NONE	Energy Fuels Expl,	Y	
331	A(30-02) 20ADD	Wells 55	510452	392,561	3,981,381		200						5						X	NONE	Energy Fuels Expl,	Y	
332	A(30-02) 24A	Wells 35	7918	398,709	3,981,618	01-Jan-66	628									550		2	K	X		Y	
332	A(30-02) 24A	Wells 35	7919	398,709	3,981,618	01-Jan-66	650					650						1	K	X		Y	
333	A(30-02) 24AAC	Wells 55	560220	398,811	3,981,718														PROD	UTIL	Anasazi Water Co,		
334	A(30-02) 24ACB	GWSI	355821112073701	398,329	3,981,484		600					600	8	6,590					U	U	Bill Thurston	Y	
335	A(30-02) 24ACB	Wells 55	524273	398,407	3,981,520														PROD	D	South Grand Canyon,	Y	
336	A(30-02) 24ACC	GWSI	355820112072001	398,302	3,981,331	01-Jan-66	628						8	6,585	29-Jun-84	545	6,040		U	U	Bill Thurston	Y	
337	A(30-02) 24ACC	GWSI	355820112072101	398,328	3,981,392	01-Jan-66	650					650		6,585				0.8	U	U	Bill Thurston	Y	
338	A(30-02) 24ACD	Wells 55	560179	398,605	3,981,317	30-Jun-97	3,120		3,100				8	6,607		2,400	4,207		PROD	UTIL	Anasazi Water Co,		
339	A(30-02) 24BAC	Wells 55	542928	398,007	3,981,724	03-May-94	3,000		2,306				13	6,607		2,400	4,207	85	PROD	D	Seibold, Halvorson,		
340	A(30-02) 24BBB	Wells 35	7920	397,606	3,981,928	01-Jan-66	730						10			542			K	X		Y	
340	A(30-02) 24BBC	GWSI	355830112081001	397,630	3,981,708	01-Sep-66	730						10	6,575	29-Jun-84	402	6,173	0.1	U	U	Bob Thurston	Y	D
341	A(30-02) 24BCA	Wells 55	518661	397,804	3,981,525														PROD	UTIL	Merrion Oil & Gas Cp,	Y	
342	A(30-02) 24BDC	Wells 55	518657	398,003	3,981,322														PROD	UTIL	Merrion Oil & Gas Cp,	Y	
343	A(30-02) 24CAA	Wells 55	523284	398,202	3,981,120	01-May-89	3,108		2,330				13					80	PROD	M	Southwestern Ground-,		
343	A(30-02) 24CAA	GWSI	355811112074501	398,125	3,981,179	01-May-89	3,108		35	2,330	3,108	3,108	13	6,578					W	MUN	Southwestern Ground Water		D
343	A(30-02) 24CAA	GWSI	355811112074501	398,125	3,981,179	01-May-89	3,108		2,330	2,330	3,108	3,108	8	6,578					W	MUN	Southwestern Ground Water		D
344	A(30-02) 25B	GWSI	355720112074001	398,232	3,979,606	01-Jan-62	630							6,650				0.1	U	U		Y	D
344	A(30-02) 25C	Wells 35	7921	397,881	3,979,212	01-Jan-61	623		15				8			560		5	M	PROD			
344	A(30-02) 25C	GWSI	355710112074001	398,228	3,979,298	01-Jan-61	623			15			8	6,725		560	6,165	4	W	MUN			D
345	A(30-02) 25DD	Wells 55	645737	398,880	3,979,002	01-Jan-60	600		43				8			574		12	PROD	D	Kaibab Natl Forest,		
346	A(30-02) 29	Wells 55	215850	391,827	3,979,678														ME	ME	Vane Minerals Group		
347	A(30-02) 32D	Wells 55	521299	392,211	3,977,661	29-Jul-88	140						5						ME	NONE	Energy Fuels Expl,	Y	
348	A(30-02) 36	Wells 55	510850	398,268	3,977,998														ME	NONE	Rocky Mtn Energy,	Y	
349	A(30-03) 24CAA	Wells 55	516234	407,830	3,981,010	10-Dec-86	305		4				8						PROD	C	Carrell, Dan,	Y	
350	A(30-03) 31B	Wells 55	520639	399,469	3,978,388														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
351	A(30-03) 33C	Wells 55	520645	402,665	3,977,542														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
352	A(30-04) 29C	Wells 55	515022	410,783	3,979,094	17-Sep-86	165						5						X	NONE	Energy Fuels Expl,	Y	
353	A(30-04) 35C	Wells 55	515023	415,585	3,977,441	18-Sep-86	70						5						X	NONE	Energy Fuels Expl,	Y	
354	A(30-05) 11DD	Wells 55	528709	426,292	3,983,575														ME	NONE	Energy Fuels Nuclear,	Y	
355	A(30-05) 22	Wells 55	217273	424,064	3,980,974																Vane Minerals (U.S.) LLC		
356	A(30-05) 24	Wells 55	217270	427,281	3,980,953																Vane Minerals (U.S.) LLC		
357	A(30-05) 25AB	Wells 55	508115	427,475	3,979,948	17-Aug-84													X	NONE	Energy Fuels Expl,	Y	
358	A(30-06) 15DC	Wells 55	508116	433,939	3,981,931	17-Aug-84													X	NONE	Energy Fuels Expl,	Y	
359	A(30-06) 27D	Wells 55	518646	434,114	3,978,902	15-Oct-87	200						5						ME	NONE	Energy Fuels Expl,	Y	
360	A(30-06) 29CC	Wells 55	508117	429,884	3,978,718	28-Aug-84													ME	NONE	Energy Fuels Expl,	Y	
361	A(30-06) 32CC	Wells 35	7922	429,877	3,977,113	01-Jan-68	1,330												K	X		Y	
361	A(30-06) 32CC	GWSI	355610111464001	429,779	3,977,141	01-Jan-68	1,330					1,330		6,220					U	U		Y	
362	A(31-01) 18	Wells 55	510569	380,710	3,992,739	01-Sep-85													X	NONE	Pathfinder Mines Crp,	Y	
363	A(31-01) 18BCC	Wells 55	579014	380,019	3,992,850														PROD	D	Johnson	Y	
364	A(31-02) 26	Wells 55	577829	396,777	3,989,295														G	NONE	NPS	Y	
365	A(31-02) 26BBB	Wells 55	577830	396,065	3,990,007	03-May-00	23		23				2						MON	T	NPS		
366	A(31-02) 26BBB	Wells 55	577831	396,065	3,990,007	08-Dec-99	11		11				2						MON	T	NPS		
367	A(31-02) 26BBB	Wells 55	577832	396,065	3,990,007	08-Dec-99	17		17				2						MON	T	NPS		
368	A(31-02) 33ABB	Wells 35	7925	393,647	3,988,430								18			14			K	X		Y	
368	A(31-02) 33ABB	GWSI	360205112104601	393,678	3,988,442									6,675	1-Dec-64	14	6,661		U	U		Y	
369	A(31-04) 26CCD	Wells 55	528960	415,575	3,988,367														PROD	D	Jeffries, Charles,	Y	
370	A(33-08) 07B	GWSI	361637111350301	447,471	4,014,824	29-Aug-60	1,292		21	21	1292	1,292	8.62	5,480	29-Aug-60				U	U	Navajo	Y	G
371	A(34-08) 35B	GWSI	361808111305001	453,798	4,017,592		3,440					3,440		5,830	1-Jan-64	2,200	3,630		OG	UND	Collins Burrell		D

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
372	A(34-08) CD	AOGC		454,822	4,017,529	01-Jan-47	3,440							5,781						DH	Collins-Cobb		
373	A(35-03) 25DAA	Wells 55	500670	408,458	4,029,032		1,000												PROD	ME	Cluff,D F	Y	
374	A(35-04) 01BBB	Wells 55	500963	416,714	4,036,244		800												PROD	I	Slipher,J M	Y	
375	A(35-08) 01D	GWSI	362722111291201	456,328	4,034,649	26-Mar-56	996		12	860	996	996	10.75	6,260	26-Mar-56	870	5,390	3	W	D	Navajo		D
375	A(35-08) 01D	GWSI	362722111291201	456,328	4,034,649	26-Mar-56	996		134	860	996	996	8.62	6,260	26-Mar-56	870	5,390	3	W	D	Navajo		G
375	A(35-08) 01D	GWSI	362722111291201	456,328	4,034,649	26-Mar-56	996	134	390	860	996	996	6.62	6,260	26-Mar-56	870	5,390	3	W	D	Navajo		D
375	A(35-08) 01D	GWSI	362722111291201	456,328	4,034,649	26-Mar-56	996	390	860	860	996	996	5	6,260	26-Mar-56	870	5,390	3	W	D	Navajo		D
376	A(36-05) 27B	GWSI	362957111512601	423,165	4,039,656									3,120					U	U	NPS	Y	
377	A(36-05) 34A	GWSI	362837111504201	424,238	4,037,182									2,880					U	U	NPS	Y	
378	A(36-06) 05D	GWSI	362737111463701	430,320	4,035,282	29-Jan-60	1,000				1,000	1,000		5,530	29-Jan-60				X	U	Navajo	Y	G
379	A(36-08) 11A	GWSI	363204111300801	454,980	4,043,345	17-Apr-56	1,200		1,090	1,060	1,090	1,200	6.62	6,420	17-Apr-56	993	5,427	5	W	D	Navajo		D
379	A(36-08) 11A	GWSI	363204111300801	454,980	4,043,345	17-Apr-56	1,200		1,090	1,090	1,120	1,200	6.62	6,420	17-Apr-56	993	5,427	5	W	D	Navajo		D
380	A(36-09) 02B	GWSI	363311111235401	464,288	4,045,366	02-Mar-68	1,116		18	997	1,116	1,116	10.75	6,100	2-Mar-68	957	5,143	7	W	UND	Navajo		D
380	A(36-09) 02B	GWSI	363311111235401	464,288	4,045,366	02-Mar-68	1,116		997	997	1,116	1,116	6.62	6,100	2-Mar-68	957	5,143	7	W	UND	Navajo		D
381	A(36-09) 02C	GWSI	363248111235001	464,385	4,044,657	19-Aug-41	870		819	819	870	870	6.62	6,050	14-Jan-54	786	5,264	2.5	U	U	Navajo	Y	D
381	A(36-09) 02C	GWSI	363248111235001	464,385	4,044,657	19-Aug-41	870		819	781	818	870	6.62	6,050	14-Jan-54	786	5,264	2.5	U	U	Navajo	Y	D
382	A(36-09) 09A	GWSI	363215111253601	461,745	4,043,652	01-Aug-51	585					585	8	5,850	12-Jan-53	461	5,389	19	W	S	Navajo		G
383	A(37-05) 04A	Wells 55	805376	423,015	4,055,148	31-Dec-53	125		4				32					20	PROD	S	North Rim Ranch, LLC		
384	A(37-05) 04ABC	GWSI	363822111515101	422,683	4,055,223	01-Jan-72	50					50	12	4,670	4-Aug-76	13	4,657		W	S	Arlond Hawkins		
385	A(37-05) 04ACC	Wells 35	7938	422,709	4,054,846	01-Jan-50	45		45	10	45		10			15		25	S	PROD	Evans		
386	A(37-07) 01B	GWSI	363815111355001	446,546	4,054,825	30-Aug-58	1,280					1,280		6,200					U	U	Navajo	Y	D
387	A(37-07) 04C	GWSI	363759111392901	441,104	4,054,368	14-Jul-58	428					428		5,080	14-Jul-58				U	U	Navajo	Y	
388	A(37-08) 03B	GWSI	363808111315301	452,431	4,054,575	01-Jan-57	1,397		42	1,176	1,397	1,397	10.75	6,110	1-Jan-57	1,164	4,946	6.5	U	U	Navajo	Y	D
388	A(37-08) 03B	GWSI	363808111315301	452,431	4,054,575	01-Jan-57	1,397		762	1,176	1,397	1,397	7	6,110	1-Jan-57	1,164	4,946	6.5	U	U	Navajo	Y	D
388	A(37-08) 03B	GWSI	363808111315301	452,431	4,054,575	01-Jan-57	1,397	762	1,397	1,176	1,397	1,397	5	6,110	1-Jan-57	1,164	4,946	6.5	U	U	Navajo	Y	D
389	A(37-08) 03B	GWSI	363810111314201	452,704	4,054,635	04-Apr-65	1,500		20	1,400	1,500	1,500	12.75	6,115	4-Apr-65	1,200	4,915	6	UND	UND	Navajo		D
389	A(37-08) 03B	GWSI	363810111314201	452,704	4,054,635	04-Apr-65	1,500		20	1,200	1,400	1,500	12.75	6,115	4-Apr-65	1,200	4,915	6	UND	UND	Navajo		D
389	A(37-08) 03B	GWSI	363810111314201	452,704	4,054,635	04-Apr-65	1,500		1,400	1,400	1,500	1,500	8.62	6,115	4-Apr-65	1,200	4,915	6	UND	UND	Navajo		D
389	A(37-08) 03B	GWSI	363810111314201	452,704	4,054,635	04-Apr-65	1,500		1,400	1,200	1,400	1,500	8.62	6,115	4-Apr-65	1,200	4,915	6	UND	UND	Navajo		D
390	A(37-08) 03C	GWSI	363805111315301	452,430	4,054,483	10-May-38	820					820		6,110					U	U	Navajo	Y	D
391	A(37-08) 23A	GWSI	363537111301801	454,766	4,049,910	14-Jun-56	1,200		212	212	1,200	1,200	8.62	6,335	14-Jun-59	1,171	5,164	5	W	D	Navajo		D
392	A(37-09) 08C	GWSI	363702111271601	459,300	4,052,506		1,180					1,180	8	6,075	14-Jan-54	820	5,255		W	D	Navajo		
393	A(37-09) 08C	GWSI	363708111271301	459,376	4,052,691	10-Dec-59	1,220		1,090			1,220	6.62	6,080	11-Dec-59	1,010	5,070	9	W	D	Navajo		D
393	A(37-09) 08C	GWSI	363708111271301	459,376	4,052,691	10-Dec-59	1,220	1,090	1,220			1,220	4	6,080	11-Dec-59	1,010	5,070	9	W	D	Navajo		G
394	A(37-09) 08D	GWSI	363705111265201	459,897	4,052,596		602					602		6,075	22-Sep-71	416	5,659	17	UND	UND	Navajo		
395	A(37-09) 26D	GWSI	363410111240001	464,147	4,047,185	01-Jan-68	1,116			997		1,116	6	6,230	1-Mar-68	957	5,273	7	W	D			D
396	A(38-01) 14A	Wells 35	7940	387,767	4,061,960	01-Jan-61	704									660				WD			
396	A(38-01) 14ADD	GWSI	364141112150301	388,194	4,061,736	01-Jan-61	704					704	9	7,750	1-Jan-61	660	7,090		U	U	Forest Service	Y	D
397	A(38-01) 17ACA	GWSI	364143112184501	382,686	4,061,872									7,200					W	MUN	Jacob Lake		
398	A(38-02) 07AAA	GWSI	364251112130001	391,274	4,063,854		750							7,920		690	7,230		X	U	H Bowman	Y	
399	A(38-02) 08BBD	GWSI	364243112124501	391,643	4,063,603		750							7,910					X	U		Y	
400	A(38-02) 08CAD	GWSI	364218112122601	392,105	4,062,827	01-Jan-60	2,100	1					6	7,850					U	U		Y	
401	A(38-04) 36AAC	Wells 55	614369	418,329	4,056,897	31-Dec-57	7		7				36					5	PROD	S	ASLD		
402	A(38-05) 31DBB	Wells 55	614370	419,520	4,056,284	31-Dec-57	7		7				48						PROD	S	ASLD		
403	A(38-05) 32CDA	Wells 35	7942	420,913	4,055,867	01-Jan-27	6									4		3	S	PROD	Mackelprang		
404	A(38-05) 32CDB	Wells 55	614371	420,714	4,055,869	31-Dec-57	12						36			10			PROD	S	ASLD		
405	A(38-07) 28D	GWSI	363930111384501	442,216	4,057,165									4,940					W	S	Navajo		
406	A(38-07) 28D	GWSI	363932111383901	442,365	4,057,225		100					100		5,000					W	D	Navajo		
407	A(38-08) 08C	GWSI	364205111335001	449,568	4,061,895	13-Jun-59	1,287		20			1,287	8.62	5,920	12-Jun-59	1,203	4,717	5	UND	UND	Navajo		D
407	A(38-08) 08C	GWSI	364205111335001	449,568	4,061,895	13-Jun-59	1,287		1,287			1,287	6.62	5,920	12-Jun-59	1,203	4,717	5	UND	UND	Navajo		D
408	A(38-09) 34A	GWSI	363916111243701	463,267	4,056,618	16-Feb-36	1,268					1,268		5,980					X	U	Navajo	Y	D
409	A(39-01) 21DCA	Wells 55	513323	384,525	4,069,152														PROD	I	Ridi%	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
410	A(39-03) 03DBD	GWSI	364818112033201	405,477	4,073,763	20-Jul-72	125					125		5,800					W	S	Ver Clf Cc		
410	A(39-03) 03DCB	Wells 35	7944	405,214	4,073,730	20-Jul-72	125											1	S	PROD	The Signature Rocks R		
411	A(39-04) 06CBB	GWSI	364829112010001	409,247	4,074,061	01-Aug-61	700					700	6	6,610	5-Aug-76	527	6,084	5	W	S	C Sturdevant		D
411	A(39-04) 06CBB	Wells 55	641863	409,242	4,074,080	01-Jan-61	700						5			550		3	PROD	S	Sturdevant, C. Kay,		
412	A(39-04) 06CBB	Wells 55	641867	409,242	4,074,080	01-Jan-61	600						5			520		5	PROD	S	North Rim Ranch, LLC		
412	A(39-04) 06CBB	Wells 35	7946	409,242	4,074,080	01-Jan-61	600									520		5	S	PROD	Vemillian Cliff Cattle Co, Ramsey Cattle Co Inc		
413	A(39-04) 06CBB	Wells 35	7945	409,242	4,074,080	01-Jul-61	700									680		3	S	PROD	Vemillian Cliff Cattle Co, Ramsey Cattle Co Inc		
414	A(39-06) 12BAD	GWSI	364757111421501	437,117	4,072,824									4,080					W	D	Betty Rodgers		
415	A(39-06) 17DAB	GWSI	364645111461301	431,201	4,070,651									5,600					W	MUN	Art Green		
416	A(39-06) 29AB	Wells 55	806264	430,947	4,068,144	31-Dec-66													PROD	D	Tamarisk Enterprise,		
417	A(39-07) 03BAB	GWSI	364856111380701	443,275	4,074,599	10-Aug-55	1,205					1,205		3,560					X	U	Jane Foster	Y	
418	A(39-07) 08CCC	Wells 55	521955	439,665	4,071,592	05-Sep-88	40						5						ME	NONE	Energy Fuels Nuclear,	Y	
419	A(39-07) 18AC	Wells 55	515329	438,975	4,070,893	25-Aug-86													X	NONE	Energy Fuels Nuclear,	Y	
420	A(39-07) 18AC	Wells 55	521956	438,975	4,070,893	02-Sep-88	80						5						ME	NONE	Energy Fuels Nuclear,	Y	
421	A(39-07) 24B	GWSI	364557111360301	446,313	4,069,063									4,420					W	D	Navajo		
422	A(39-09) 35A	GWSI	364423111232701	465,044	4,066,070	30-Mar-38	1,420					1,420		5,670					U	U	Navajo	Y	D
423	A(39-2) AA	AOGC		392,891	4,067,019	01-May-64	3,868							7,680						DH	Underwood, Rip C.		
424	A(40-01) 05AAB	Wells 35	7947	383,311	4,084,861	27-Jan-71	610	20	610							575			S	PROD	Thomas		
425	A(40-01) 21ACB	Wells 55	645890	384,467	4,079,615	06-Apr-63	550		540				6			500		6	PROD	S	Rich,J		
425	A(40-01) 21ACB	GWSI	365120112174301	384,465	4,079,632	01-Mar-63	693		585	585	693	693	4	5,810	1-Mar-63	518	5,292	5	W	S	J Rich		
426	A(40-01) 33DBD	Wells 55	215338	384,618	4,075,798														PROD	S	Territorial Livestock		
427	A(40-04) 05DAC	GWSI	365334111591001	412,070	4,083,431		700					700		6,000					X	U	Sanders	Y	
428	A(40-04) 05DAC	GWSI	365335111591001	412,071	4,083,462		300					300		6,000					X	U	Sanders	Y	
429	A(40-04) 19BAB	GWSI	365131112004501	409,679	4,079,665	17-Apr-76	610					610		6,050	17-Apr-60	515	5,535	12	W	S	A Sanders		
430	A(40-04) 19BBB	Wells 35	37140	409,322	4,079,724	01-Jan-61	650									200		12			Sanders		
431	A(40-04) 27BBA	Wells 55	641864	414,298	4,078,066	01-Jan-52	920		600				6			860		15	PROD	S	North Rim Ranch, LLC		
432	A(40-04) 27BBA	Wells 35	7948	414,298	4,078,066	01-Nov-50	1,320		700	550	600		6			560		5	S	PROD	Vermillian Cliff Cattle Co, Ramsey Cattle Co Inc		
433	A(40-04) 27BBC	GWSI	365035111574401	414,143	4,077,893	01-Jul-52	920		550			920	6	6,330	1-Jul-69	860	5,470	5	W	D	C Sturdevant		
434	A(40-04) 27BBD	Wells 35	7949	414,296	4,077,866		780									640			S	PROD			
435	A(40-05) 05CCC	Wells 35	7950	420,562	4,083,038	01-Jun-60	1,340		1,200				4			1,320		5	S	PROD	Vemillion Cliff Cattle Co, Ramsey Cattle Co Inc		
435	A(40-05) 05CCC	Wells 55	641865	420,562	4,083,038	01-Jan-60	1,340		1,000				5			1,100		15	PROD	S	North Rim Ranch, LLC		
436	A(40-05) 05CCC	Wells 55	641865	420,562	4,083,038	01-Jan-60	1,340		1,000				5			1,100		15	PROD	S	North Rim Ranch, LLC		
437	A(40-05) 05CCC	GWSI	365325111532701	420,558	4,083,070	01-Jun-60	1,340		1,000	1,000	1,340	1,340	5	6,160	1-Jul-69	1,100	5,060	5	W	S	C Sturdevant		D
438	A(40-05) 12DD	Wells 55	641866	428,266	4,081,437	01-Jan-51	1,400						6					5	PROD	S	North Rim Ranch, LLC		
439	A(40-05) 12DDB	GWSI	365237111481901	428,169	4,081,523	10-Jul-62	1,468					1,468	4	6,210	10-Jul-62	1,310	4,900	15	W	S	ASLD		D
439	A(40-05) 12DDB	Wells 55	614372	428,167	4,081,539	01-Jan-51	1,500		1,500				6			1,300			PROD	S	ASLD		
439	A(40-05) 12DDD	Wells 35	7951	428,365	4,081,334	07-Jul-62	1,468		1,468				4					15	S	PROD	Findlay		
440	A(40-05) 33CBC	GWSI	364910111522701	421,971	4,075,199		1,175					1,175		6,400	14-Jun-51	950	5,450		W	S	C Sturdevant		
440	A(40-05) 33CBC	Wells 55	641861	422,068	4,075,374	01-Jan-51	1,077		900				6			900		5	PROD	S	North Rim Ranch, LLC		
441	A(40-06) 03CCC	Wells 35	7952	433,331	4,082,894	01-Jun-60	1,810		1,800	1,750	1,800		4			1,760		3	S	PROD	Vemillion Cliff Cattle Co, Ramsey Cattle Co Inc		
441	A(40-06) 03CCC	Wells 55	641862	433,331	4,082,895	01-Jan-60	1,810		1,800				5			1,500			PROD	S	North Rim Ranch, LLC		
441	A(40-06) 03CCC	GWSI	365325111445201	433,305	4,082,961	11-Dec-59	1,802		1,762	1,762	1,802	1,802	4	6,150	1-Jul-69	1,500	4,650	3	W	S	C Sturdevant		D
442	A(40-07) 13ACB	GWSI	365208111354301	446,880	4,080,492		200					200		3,190	4-Aug-76	175	3,015		U	U	NPS	Y	
443	A(40-07) 13ACB	Wells 35	7953	446,967	4,080,584		200									30		27	D	PROD			
444	A(40-07) 13ACC	GWSI	365204111353801	447,003	4,080,368	01-Oct-63	80		80	50	80	80	6.62	3,160	4-Aug-76	20	3,140	50	U	U	NPS	Y	
444	A(40-07) 13ACC	GWSI	365204111353801	447,003	4,080,368	01-Oct-63	80		44	50	80	80	8.62	3,160	4-Aug-76	20	3,140	50	U	U	NPS	Y	
444	A(40-07) 13ACC	Wells 55	807332	446,966	4,080,384		56						6						PROD	NONE	NPS		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
445	A(40-07) 13DAA	Wells 55	558318	447,568	4,080,180	05-Dec-96	70		50				8			24			X	D	NPS - Glen Canyon NRA	Y	
445	A(40-07) 13DAA	Wells 55	558319	447,568	4,080,180	04-Dec-96	72		50				8			24			X	D	NPS - Glen Canyon NRA	Y	
445	A(40-07) 13DAA	Wells 55	906425	447,568	4,080,180															NONE	U.S. Department of Interior	Y	
446	A(40-07) 30ACA	GWSI	365022111405201	439,206	4,077,277									4,800					W	D	Betty Rodgers		
447	A(40-07) 34	Wells 55	624933	443,629	4,075,477	01-Jan-70	540		525				6			450		20	PROD	D	Marble Canyon Co,		
448	A(40-07) 34ACC	Wells 35	7954	443,730	4,075,580	16-Aug-69	540		500	500	540		6			450		20	D	PROD	U.S. Department of Interior		
449	A(40-07) 34ACC	GWSI	364932111375101	443,679	4,075,706	01-Aug-69	540		540	500	540	540	6	3,475	5-Aug-76	482	2,993	20	W	MUN	Marble Canyon Co		
450	A(40-07) 34ADC	Wells 55	526708	444,131	4,075,582	22-Jan-90	130												X	NONE	ADOT,	Y	
451	A(40-07) 34DCD	Wells 55	526707	443,925	4,074,773	18-Feb-90	168												X	NONE	ADOT,	Y	
452	A(40-08) 18CAB	GWSI	365200111345001	448,190	4,080,238	01-Sep-63	200					200		3,155	24-Sep-63	30	3,125		X	U	NPS	Y	
453	A(40-08) 18CBA	GWSI	365158111345401	448,091	4,080,177	01-Mar-38	34					34		3,160	14-Feb-63	23	3,137		X	U		Y	
454	A(40-08) 18CBB	Wells 55	562699	447,770	4,080,190														PROD	C	National Park Svc,		
455	A(40-08) 18DBC	GWSI	365150111343901	448,461	4,079,928									3,200					U	U	NPS	Y	
456	A(40-08) 18DBC	GWSI	365150111344001	448,436	4,079,928	01-Aug-63	203		113	113	203	203		3,148	3-Sep-63	23	3,125	33	X	U	NPS	Y	
457	A(40-08) 23B	GWSI	365125111302301	454,796	4,079,122	17-Sep-58	1,406		44	44	1406	1,406	8.62	4,430	17-Sep-58	1,170	3,260	6	W	D	Navajo		D
458	A(40-08) 34D	GWSI	364900111305401	454,004	4,074,658	04-Oct-58	1,402		20	20	1402	1,402	8.62	4,770	4-Oct-58	1,330	3,440	5	W	D	Navajo		D
459	A(40-09) 20A	GWSI	365125111263401	460,466	4,079,094	15-Mar-61	1,500					1,500	10.75	4,750	17-Mar-61	1,190	3,560	30	W	D	Navajo		G
460	A(40-2) DD	AOGC		394,578	4,078,677	01-Sep-86	4,016							7,117						DH	Medallion Oil		
461	A(41-01) 33CCC	Wells 55	807163	383,770	4,085,064	27-Jan-71	610		20				6			575		25	PROD	S	Mangum		
462	A(41-01) 33CCC	Wells 35	7957	383,770	4,085,064	27-Jan-71	610		20				7			575		17	S	PROD	Thomas		
463	A(41-01) 33CCC	GWSI	365416112181701	383,697	4,085,066	27-Jan-71	610		20	20	610	610	6.66	5,450	27-Jan-71	575	4,875	10	W	S	Earl Mangum		D
464	A(41-02) 30DDB	Wells 55	579181	391,464	4,086,756	25-Feb-00	15		5				2			10			MON	T	Town of Fredonia		
465	A(41-03) 13CBC	GWSI	365707112020301	407,859	4,090,040									5,260					W	S	Trevor Leach		
466	A(41-04) 14CBB	GWSI	365716111560601	416,692	4,090,226	01-Jan-54	600					600		5,580					X	U		Y	
467	A(41-04) 16CBB	GWSI	365716111581601	413,476	4,090,258	01-Jan-54	700					700		5,730					X	U		Y	
468	A(41-04) 28AD	Wells 55	806752	414,065	4,087,224	31-Dec-54												3	PROD	S	North Rim Ranch, LLC		
469	A(41-04) 28AD	Wells 55	806751	414,065	4,087,224	31-Dec-65	600											2	PROD	S	North Rim Ranch, LLC		
470	A(41-04) 28ADA	GWSI	365540111574801	414,139	4,087,293		920					920		5,875	1-Jun-72	700	5,175		W	S	C Sturdevant		
470	A(41-04) 28ADA	Wells 35	7958	414,168	4,087,323		920												S	PROD	Sanders		
471	A(41-07) 13ACA	Wells 55	806100	447,533	4,090,265	06-Dec-65	970		300				6			940		12	PROD	S	Kanab Cattle Company		
472	A(41-08) 01BBA	Wells 55	807333	456,440	4,093,819		703						12						PROD	NONE	NPS		
473	A(41-08) 03	Wells 55	800203	453,678	4,093,135		965		980				8			492		45	PROD	C	Ara Leisure Serv Inc,		
474	A(41-08) 04DDA	Wells 35	7959	452,769	4,092,641	01-Jan-61	925		893				9			849			D	PROD	Canyon Tours Inc		
474	A(41-08) 04DDA	Wells 55	614373	452,769	4,092,641	01-Jan-61	925		893				9			849			PROD	D	ASLD	Y	
474	A(41-08) 04DDA	GWSI	365844111314501	452,840	4,092,660	20-Oct-61	925		793	883	925	925	8	4,120	18-Jun-81	492	3,628		W	MUN	ASLD		D
474	A(41-08) 04DDA	GWSI	365844111314501	452,840	4,092,660	20-Oct-61	925		793	793	883	925	8	4,120	18-Jun-81	492	3,628		W	MUN	ASLD		D
475	A(41-08) 09CCA	Wells 55	637389	451,559	4,091,046	22-Jun-64	1,200		1,010				14			865		30	PROD	D	ADOT - Page Maintnance Camp		
475	A(41-08) 14BCA	GWSI	365723111302801	454,770	4,090,144	01-Feb-58	1,200		8	880	1,010	1,200	18	4,112	30-Oct-08	511	3,601	180	W	MUN	ADOT		
475	A(41-08) 14BCA	GWSI	365723111302801	454,770	4,090,144	01-Feb-58	1,200		8	1,030	1,200	1,200	18	4,112	30-Oct-08	511	3,601	180	W	MUN	ADOT		
475	A(41-08) 14BCA	GWSI	365723111302801	454,770	4,090,144	01-Feb-58	1,200		1,030	880	1,010	1,200	14	4,112	30-Oct-08	511	3,601	180	W	MUN	ADOT		
475	A(41-08) 14BCA	GWSI	365723111302801	454,770	4,090,144	01-Feb-58	1,200		1,030	1,030	1,200	1,200	14	4,112	30-Oct-08	511	3,601	180	W	MUN	ADOT		
476	A(41-08) 14BCB	GWSI	365726111303201	454,632	4,090,247	01-Oct-57	1,500		11	11	1,500	1,500	10.75	4,120	1-Oct-57	880	3,240	100	UND	UND			GMG
477	A(41-08) 23DAC	GWSI	365611111294301	455,832	4,087,929	01-Jan-58	910		18	755	910	910	10.75	3,917	28-Sep-07	384	3,533	30	MON	U	Bureau of Reclamation	Y	N
477	A(41-08) 23DAC	GWSI	365611111294301	455,832	4,087,929	01-Jan-58	910		910	755	910	910	7	3,917	28-Sep-07	384	3,533	30	MON	U	Bureau of Reclamation	Y	N
478	A(41-08) 23DCD	GWSI	365557111295701	455,492	4,087,489	01-Jul-57	1,285		6	6	1,285	1,285	18	3,982	28-Sep-07	479	3,503	34	MON	U	Bureau of Reclamation	Y	GM
479	A(41-09) 19B	GWSI	365631111281701	457,962	4,088,535	01-Jul-65	560					560		3,920	28-Sep-07	264	3,656		MON	U	Bureau of Reclamation		
480	A(41-09) 35	Wells 55	637623	464,891	4,085,011	26-Feb-79	1,200		80				8			920			MON	MON	Salt River Project,		
481	A(41-1) CB	AOGC		380,737	4,089,358	01-Dec-84	3,756							5,016						DH	Shields Explr. Co.		
482	A(41-1) CB	AOGC		380,711	4,089,392	01-Sep-82	420							5,025						DH	Shields Explr. Co.		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
483	A(41-2) DA	AOGC		399,711	4,090,378	01-Oct-82	700							6,560						DH	Gary Drilling		
484	A(42-08) 32CDD	Wells 55	600601	450,355	4,094,028	15-Oct-72	935		935				12			580		600	PROD	IND	Greenehaven Dev Corp,		
484	A(42-08) 32CDD	Wells 35	7961	450,355	4,094,028	15-Oct-72	935		20	607	935		20			604		600	D	PROD	Canyon Tours Inc		
484	A(42-08) 32CDD	Wells 35	7961	450,355	4,094,028	15-Oct-72	935		935	607	935		12			604		600	D	PROD	Canyon Tours Inc		
484	A(42-08) 32CDD	GWSI	365930111332401	450,400	4,094,092	15-Oct-72	935		20	607	935	935	20	4,100	10-Jun-81	510	3,590	600	W	MUN	Greenhaven Develoment Corp		D
484	A(42-08) 32CDD	GWSI	365930111332401	450,400	4,094,092	15-Oct-72	935		935	607	935	935	12	4,100	10-Jun-81	510	3,590	600	W	MUN	Greenhaven Develoment Corp		D
485	A(42-08) 35BBB	Wells 55	621902	454,607	4,094,927	01-Aug-64	620		620				7			402		290	X	D	NPS Glen Canyon NRA	Y	
486	A(42-08) 35CCD	Wells 55	621901	454,796	4,093,995	22-Jun-72	800		800				14			285		573	PROD	D	NPS		
487	A(42-08) 35DAB	GWSI	365947111294901	455,718	4,094,586	01-Mar-58	620		40	416	620	620	20	3,735	1-Mar-58	402	3,333		W	MUN	NPS		D
487	A(42-08) 35DAB	GWSI	365947111294901	455,718	4,094,586	01-Mar-58	620	40	416	416	620	620	16	3,735	1-Mar-58	402	3,333		W	MUN	NPS		D
488	A(42-08) 35DAB	GWSI	365952111294701	455,768	4,094,740		675		76	76	603	603	20	3,736	14-Nov-81	71	3,665		UND	UND			N
489	A(42-08) 35DAD	GWSI	365945111293601	456,039	4,094,523	01-Jan-58	625		55	475	550	625	18.75	3,742	1-Jan-58	423	3,319	1000	UND	UND	Bureau of Reclamation		
489	A(42-08) 35DAD	GWSI	365945111293601	456,039	4,094,523	01-Jan-58	625		625	475	550	625	14	3,742	1-Jan-58	423	3,319	1000	UND	UND	Bureau of Reclamation		
490	A(42-08) 35DCD	GWSI	365928111295001	455,690	4,094,001	01-Feb-74	800			596	636	800		3,900	1-Feb-74	285	3,615		W	MUN	NPS		
490	A(42-08) 35DCD	GWSI	365928111295001	455,690	4,094,001	01-Feb-74	800			677	760	800		3,900	1-Feb-74	285	3,615		W	MUN	NPS		
490	A(42-08) 35DCD	GWSI	365928111295001	455,690	4,094,001	01-Feb-74	800			430	516	800		3,900	1-Feb-74	285	3,615		W	MUN	NPS		
491	A(42-08) 36CBC	GWSI	365942111292501	456,327	4,094,388	01-Jan-59	655		77	77	655	398	20	3,736	28-Sep-07	131	3,605	1200	MON	U	Bureau of Reclamation		T
492	A(42-08) 36CCC	Wells 35	7962	456,240	4,093,984	01-Oct-57	625		40	500	520		8			410		100	D	PROD	Canyon Tours Inc		
492	A(42-08) 36CCC	Wells 35	7962	456,240	4,093,984	01-Oct-57	625	40	500	500	520		8			410		100	D	PROD	Canyon Tours Inc		
492	A(42-08) 36CCC	Wells 35	7962	456,240	4,093,984	01-Oct-57	625	500	520	500	520		8			410		100	D	PROD	Canyon Tours Inc		
492	A(42-08) 36CCC	GWSI	365929111293201	456,135	4,094,029	01-Oct-57	625		500	500	625	625	8	3,840	1-Oct-57	410	3,430	100	U	U	Canyon Tours Inc		
493	A(42-08) 36CCC	GWSI	365930111292501	456,308	4,094,059	01-Feb-61	703		503	503	703	703	13.37	3,760	12-Aug-76	84	3,676	275	W	MUN	NPS		D
493	A(42-08) 36CCD	Wells 35	7963	456,441	4,093,984	02-Feb-61	703		703	503	703		12			453		275	D	PROD	NPS		
494	B(24-09) 05BAB	Wells 55	211547	295,682	3,930,839	04-May-06	1,330		1,330				5			1,000			PROD	D	Nielsen		
495	B(25-08) 34AA	GWSI	353050113070001	307,983	3,932,095	01-Jan-58	1,943			100		1,943	7	5,230	1-Jul-58	1,185	4,045		U	U		Y	D
496	B(25-09) 19CBA	Wells 55	573042	292,731	3,934,922		1,900		1,160				12			1,220			PROD	C	Chemical Lime Company of America		
497	B(25-09) 26	Wells 35	13872	299,633	3,933,259		1,700						10			1,385		10	K	X		Y	
497	B(25-09) 26DBC	GWSI	353120113120001	299,649	3,932,866	01-Feb-60	1,700					1,700	8	5,480	16-Mar-04	1,341	4,139		U	U	Howard Duncan	Y	D
498	B(25-09) 33CAB	Wells 55	904623	296,074	3,931,628	12-Apr-06	505		8				8							D	Morgan		
499	B(25-10) 26CDA	GWSI	353104113185801	289,903	3,932,933	20-May-73	1,652		36	520	1,642	1,652	20	5,150	22-Apr-87	929	4,221	37	W	IND	Flintkote		D
499	B(25-10) 26CDA	GWSI	353104113185801	289,903	3,932,933	20-May-73	1,652		36	1,642	1,652	1,652	20	5,150	22-Apr-87	929	4,221	37	W	IND	Flintkote		D
499	B(25-10) 26CDA	GWSI	353104113185801	289,903	3,932,933	20-May-73	1,652	36	1,642	520	1,642	1,652	10.75	5,150	22-Apr-87	929	4,221	37	W	IND	Flintkote		D
499	B(25-10) 26CDA	GWSI	353104113185801	289,903	3,932,933	20-May-73	1,652	36	1,642	1,642	1,652	1,652	10.75	5,150	22-Apr-87	929	4,221	37	W	IND	Flintkote		D
499	B(25-10) 26CDA	Wells 35	13873	289,872	3,932,979	28-Sep-73	1,652		1,642	520	1,642		20			878		37	D	PROD	Flintkote Co		
500	B(25-10) 35BBB	Wells 55	627216	289,260	3,932,590	19-Apr-03	1,043		315				10						PROD	D	Chemstar Lime,		
500	B(25-10) 35BBB	GWSI	353053113192201	289,290	3,932,608		1,043					1,043		5,115	9-Nov-95	451	4,664		W	MIN	Chemical Lime		
501	B(25-10) 36AAA	Wells 55	571438	292,272	3,932,519	16-Mar-99	1,570		1,570				7			916			PROD	D	Chemical Lime Company of America		
502	B(25-10) 36BDD	Wells 55	806334	291,454	3,931,935	31-Dec-75	1,652						12			700		45	PROD	IND	Chemstar Line,		
503	B(25-11) 26ABB	Wells 55	627228	280,469	3,934,412	09-Sep-13	723		555				15			404			PROD	M	Atchison-Topeka,		
504	B(25-11) 26BAD	GWSI	353137113252001	280,303	3,934,181		924					924	6	4,795	22-Apr-87	262	4,533		W	MUN	Hualapai Indian Tribe		
504	B(25-11) 26BAD	Wells 55	627227	280,263	3,934,216	23-Oct-03	924		732				10						PROD	M	Atchison-Topeka,		
505	B(25-8) AA	AOGC		308,271	3,932,061	01-Jul-58	1,943							5,410						DH	Ray Terry Oil		
506	B(26-07) 05AB	GWSI	354020113025001	314,647	3,949,525	01-Jan-72	500			20			8	5,800					U	U		Y	D
506	B(26-07) 05AB	Wells 35	13895	314,680	3,949,637	01-Jan-72	500		20				8						K	X		Y	
507	B(27-03) 30	Wells 55	515164	351,190	3,951,457	07-Oct-86	1,920		5										X	NONE	Rocky Mtn Energy,	Y	
508	B(27-03) 30	Wells 55	520756	351,190	3,951,457	05-Apr-88	1,700						5						ME	NONE	Union Pacific Res.Co,	Y	
509	B(28-01) 18CCA	Wells 55	613918	370,165	3,963,351	01-Jan-73	1,210		1,210				6			1,180		4	PROD	D	Cataract Livestock,		
509	B(28-01) 18CCA	Wells 35	13946	370,165	3,963,351	19-Jun-74	1,210		1,210				7			49		4	S	PROD	Cataract Livestock Co		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
510	B(28-01) 35AAC	Wells 35	13947	377,544	3,959,405	01-Jan-52	3,544												K	X		Y	
511	B(28-01) 35ACA	GWSI	354610112212001	377,250	3,959,103	30-Apr-52	3,544		316	2,205	3,544	3,544	13.38	6,005					U	U	Sinclair Oil And Gas Co.	Y	G
511	B(28-01) 35ACA	GWSI	354610112212001	377,250	3,959,103	30-Apr-52	3,544	316	2,205	2,205	3,544	3,544	9.62	6,005					U	U	Sinclair Oil And Gas Co.	Y	G
511	B(28-01) 35CAB	Wells 55	613915	376,730	3,958,811	01-Jan-52	3,544						13						PROD	S	Cataract Livestock,		
512	B(28-05) 19	Wells 55	521967	332,263	3,962,835	25-Feb-89	1,100						5						ME	NONE	U.P.R.C.,	Y	
513	B(28-06) 23	Wells 55	513148	329,220	3,963,218	01-Oct-86	1,400						5						X	NONE	Rocky Mtn Energy,	Y	
514	B(28-06) 23	Wells 55	516526	329,220	3,963,218	23-Jan-87	1,990						5						ME	NONE	Rocky Mtn Energy,	Y	
515	B(28-06) 23	Wells 55	527375	329,220	3,963,218	15-Jun-90	610						5						ME	NONE	Union Pacific Resc.,		
516	B(28-1) CA	AOGC		377,239	3,959,089	01-May-52	3,544							6,055						DH	Sinclair Oil & Gas		
517	B(29-01) 02CAD	Wells 55	613913	377,175	3,976,349	01-Jun-68	1,059						8			988		2	PROD	S	Cataract Livestock,		
517	B(29-01) 02CAD	Wells 35	13958	377,175	3,976,349	12-Jul-66	1,059		52				9			71		2	S	PROD	Cataract Livestock Co		
518	B(29-01) 02CAD	GWSI	355530113214001	377,141	3,976,485	01-Jul-66	1,059			52		1,059	8	5,650	1-Jul-66	988	4,662	2	W	S	ASLD		D
518	B(29-01) 02DAB	Wells 55	614908	377,781	3,976,540	01-Jan-62	1,059		1,059				8			988		2	PROD	S	ASLD		
519	B(29-01) 12DBD	GWSI	355430112202001	379,120	3,974,609	01-Jan-58	1,080			12		1,080	8	5,675	1-Oct-66	959	4,716	2	W	S	ASLD		D
519	B(29-01) 12DBD	Wells 35	13959	379,167	3,974,706	01-Jan-58	1,080		12				8			959		2	S	PROD			
520	B(29-01) 12DBD	Wells 35	13960	379,167	3,974,706	10-Apr-58	1,080						8			95		3	S	PROD	Cataract Livestock Co		
521	B(29-01) 12DBD	Wells 55	614909	379,167	3,974,707	01-Jan-58							8					2	PROD	S	ASLD		
522	B(29-01) 12DBD	Wells 55	613920	379,167	3,974,707	01-May-58	1,080						8			959		2	PROD	S	Cararact Livestock,		
523	B(29-02) 11B	Wells 55	511680	367,176	3,975,585		660						5						X	NONE	Energy Fuels Expl,	Y	
524	B(29-04) 05	Wells 55	515163	343,449	3,977,177	21-Jul-87	1,920						5						ME	NONE	Rocky Mtn Energy,	Y	
525	B(29-04) 05	Wells 55	520256	343,449	3,977,177	02-May-88	1,994						5						ME	NONE	Union Pacific,	Y	
526	B(29-04) 08	Wells 55	513515	343,427	3,975,565	20-Oct-87	1,740		5										ME	NONE	Rocky Mtn Energy,	Y	
527	B(29-04) 14	Wells 55	521968	348,230	3,973,864	18-Mar-89	1,590						5						ME	NONE	U.P.R.C.,	Y	
528	B(29-04) 35	Wells 55	520755	348,146	3,969,036	29-Apr-88	2,000						5						ME	NONE	Union Pacific Res.Co,	Y	
529	B(29-05) 27	Wells 55	520683	336,906	3,970,847	19-May-88	1,720		5										ME	NONE	Union Pacific Res.Co,	Y	
530	B(29-05) 34	Wells 55	520255	336,877	3,969,232	23-Sep-87	1,860						5						ME	NONE	Union Pacific,	Y	
531	B(30-01) 08DD	Wells 55	515442	373,158	3,984,172														ME	NONE	Energy Fuels Expl,	Y	
532	B(30-01) 17	Wells 55	520757	372,535	3,983,174														ME	NONE	Union Pacific Res.Co,	Y	
533	B(30-01) 28AAA	Wells 35	13965	374,799	3,980,625	01-Jan-42	990						8			900			K	X		Y	
534	B(30-01) 28AAA	Wells 55	613916	374,799	3,980,625	01-Jan-43	1,020						8			938		15	PROD	D	Cataract Livestock,		
535	B(30-01) 28AAA	GWSI	355750112231001	374,946	3,980,830	01-Jan-42	990						8	5,715	1-Jan-42	900	4,815		U	U		Y	D
536	B(30-01) 28AAA	GWSI	355750112231002	374,946	3,980,830	01-Jan-43	1,020		10	10	1,020	1,020	8	5,725	14-Oct-66	939	4,786		W	D	Cataract Livestock Co		
537	B(30-01) 28ABB	Wells 55	613914	374,187	3,980,637	01-Sep-60	1,051						8			905		15	PROD	D	Cataract Livestock,		
537	B(30-01) 28BAA	GWSI	355740112234001	374,190	3,980,533	01-Jan-60	1,051					1,051		5,680	1-Sep-60	905	4,775	5	U	U	Cataract Livestock Co	Y	D
537	B(30-01) 28BAA	Wells 35	13966	373,983	3,980,641	01-Jan-60	1,051									905		5	K	X		Y	
538	B(30-02) 24	Wells 55	517451	369,286	3,981,613														ME	NONE	Pathfinder Mines Crp,	Y	
539	B(30-02) 24	Wells 55	527378	369,286	3,981,613	01-Jul-90	1,780						6						X	NONE	Union Pacific Resc,	Y	
540	B(30-02) 24CDD	Wells 55	907987	369,180	3,980,910		2,000		20				8							ME	Neutron Energy Inc.	Y	
541	B(30-02) 27	Wells 55	514226	366,041	3,980,040	10-Nov-86	1,600						5						X	NONE	Pathfinder Mines Crp,	Y	
542	B(30-04) 27	Wells 55	527920	346,731	3,980,350	30-Apr-90	1,820						5						X	NONE	Union Pacific Resc.,	Y	
543	B(30-04) 33ADA	Wells 55	517660	345,799	3,979,055	24-Feb-88	1,820						5						ME	NONE	Rocky Mtn Energy,	Y	
544	B(30-05) 06DDD	Wells 55	522168	333,084	3,986,318	25-Apr-89	1,740		5										ME	NONE	Union Pacific Resour,	Y	
545	B(31-01) 12C	Wells 55	515441	378,724	3,993,977														ME	NONE	Energy Fuels Expl,	Y	
546	B(31-01) 27C	Wells 55	511683	375,440	3,989,192														ME	NONE	Energy Fuels Expl,	Y	
547	B(31-01) 27C	Wells 55	513363	375,440	3,989,192	12-Jun-86			200				6						X	NONE	Energy Fuels Expl,	Y	
548	B(31-04) 13	Wells 55	520340	350,194	3,993,202	06-May-88	2,000						5						ME	NONE	U.P.R.C.,	Y	
549	B(31-04) 13	Wells 55	527373	350,194	3,993,202	01-Sep-90	780						5						X	NONE	Union Pacific Resc,	Y	
550	B(31-04) 15	Wells 55	516527	346,972	3,993,258	16-Nov-87	2,060						5						ME	NONE	Rocky Mtn Energy,	Y	
551	B(31-04) 15CCA	Wells 55	520201	346,464	3,992,754	25-Feb-88	1,853						3						ME	NONE	Union Pacific Res Co,	Y	
552	B(31-04) 16	Wells 55	511544	345,368	3,993,275	08-Jun-86	1,620						5						X	NONE	Rocky Mtn Energy,	Y	
553	B(31-04) 16	Wells 55	527377	345,368	3,993,275	01-Sep-90	1,720						6						X	NONE	Union Pacific Resc.,	Y	
554	B(31-04) 31	Wells 55	524498	342,072	3,988,498	26-Sep-89	1,820						5						ME	NONE	Union Pacific Res.,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
555	B(31-05) 32	Wells 55	521969	334,025	3,988,608	09-Sep-88	2,060						5						ME	NONE	U.P.R.C.,	Y	
556	B(31-05) 32	Wells 55	527379	334,025	3,988,608	01-May-90	1,940						4						X	NONE	Union Pacific Resc.,	Y	
557	B(32-05) 23	Wells 55	516100	339,073	4,001,376	14-Nov-86	1,620						5						X	NONE	Rocky Mtn Energy,	Y	
558	B(33-09) 17CD	Wells 55	515328	294,875	4,014,564	24-Nov-86	1,360						5						X	NONE	Energy Fuels Nuclear,	Y	
559	B(33-09) 17CD	Wells 55	518919	294,875	4,014,564	15-Sep-87	1,900						5						ME	NONE	Energy Fuels Nuclear,	Y	
560	B(33-10) 08	Wells 55	515028	285,491	4,016,991	08-Sep-86	2,130		5										X	NONE	Rocky Mtn Energy,	Y	
561	B(33-10) 12A	Wells 55	521576	292,331	4,017,230	15-Aug-88	1,040						5						ME	NONE	Energy Fuels Nuclear,	Y	
562	B(33-10) 17	Wells 55	521915	285,451	4,015,382	10-Sep-88	680						5						ME	NONE	Union Pacific Res.,	Y	
563	B(33-10) 18	Wells 55	525089	283,846	4,015,421	05-May-90	1,960						5						X	NONE	Union Pacific Res.,	Y	
564	B(34-04) 16D	GWSI	362047112432901	345,163	4,023,749									1,800					U	U	NPS	Y	
565	B(34-09) 31	Wells 55	513150	293,605	4,020,016	18-Sep-86	2,120						8						X	NONE	Rocky Mtn Energy,	Y	
566	B(34-09) 31	Wells 55	517659	293,605	4,020,016	12-Aug-87	900						5						ME	NONE	Rocky Mtn Energy,	Y	
567	B(34-09) 31	Wells 55	524506	293,605	4,020,016	14-Jun-89	900						5						ME	NONE	Union Pacific Res.,	Y	
568	B(34-10) 23B	Wells 55	521575	290,070	4,023,727	08-Aug-88	500						5						ME	NONE	Energy Fuels Nuclear,	Y	
569	B(34-10) 35	Wells 55	527923	290,392	4,020,094	09-Apr-90	1,920						5						X	NONE	Union Pacific Resc.,	Y	
570	B(35-04) 06AB	Wells 55	533129	342,327	4,037,300														ME	NONE	Energy Fuels Nuclear,	Y	
571	B(35-04) 07	Wells 55	213617	342,080	4,035,091	14-Oct-07	500						7						ME	ME	Quaterra Resources	Y	
572	B(35-04) 18	Wells 55	213541	342,047	4,033,484														ME	ME	Quaterra Resources		
573	B(35-04) 18	Wells 55	908698	342,047	4,033,484																Quaterra Alaska		
574	B(35-04) 18	Wells 55	909339	342,047	4,033,484																Quaterra Alaska		
575	B(35-04) 18AA	Wells 55	523531	342,640	4,034,075	01-May-89													X	NONE	Energy Fuels Nuclear,	Y	
576	B(35-04) 18AA	Wells 55	535128	342,640	4,034,075	24-Jul-92	1,800												ME	NONE	Energy Fuels Nuclear,	Y	
577	B(35-04) 18BB	Wells 55	528050	341,481	4,034,100	06-Jun-90													X	NONE	Energy Fuels Nuclear,	Y	
578	B(35-04) 18BB	Wells 55	538113	341,481	4,034,100	27-Apr-93													ME	NONE	Energy Fuels Nuclear,	Y	
579	B(35-04) 18BB	Wells 55	542481	341,481	4,034,100														ME	NONE	Energy Guels Nuclear,	Y	
580	B(35-05) 01	Wells 55	507705	340,536	4,036,728														ME	NONE	Energy Fuels Nuclear,	Y	
581	B(35-05) 01BB0	Wells 55	514724	339,942	4,037,343	19-Aug-86	200						5						X	NONE	Energy Fuels Nuclear,	Y	
582	B(35-05) 02	Wells 55	507701	338,923	4,036,759														ME	NONE	Energy Fuels Nuclear,	Y	
583	B(35-05) 02	Wells 55	514725	338,923	4,036,759	06-Nov-86	194						5						X	NONE	Energy Fuels Nuclear,	Y	
584	B(35-05) 05C	Wells 55	535124	333,673	4,036,463														ME	NONE	Energy Fuels Nuclear,	Y	
585	B(35-05) 10AB	Wells 55	518223	337,497	4,035,779	28-Aug-87	306						5						ME	NONE	Energy Fuels Nuclear,	Y	
586	B(35-05) 13	Wells 55	908832	340,470	4,033,511																Quaterra Alaska		
587	B(35-05) 14	Wells 55	528227	338,863	4,033,533	13-Jun-90													X	NONE	Energy Fuels Nuclear,	Y	
588	B(35-05) 14A	Wells 55	520720	339,274	4,033,931	08-Jul-88	289						5						ME	NONE	Energy Fuels Nuclear,	Y	
589	B(35-05) 14BD	Wells 55	539341	338,665	4,033,736														ME	NONE	Energy Fuels Nuclear,	Y	
590	B(35-05) 14BD	Wells 55	542483	338,665	4,033,736														ME	NONE	Energy Fuels Nuclear,	Y	
591	B(35-05) 35BD	Wells 55	520719	338,558	4,028,929	06-Oct-88	1,675						5						X	NONE	Energy Fuels Nuclear,	Y	
592	B(35-06) 03	Wells 55	514682	327,677	4,036,989	20-Oct-86	110						5						X	NONE	Energy Fuels Nuclear,	Y	
593	B(35-06) 03B00	Wells 55	518222	327,281	4,037,399	21-Jun-87	440						5						ME	NONE	Energy Fuels Nuclear,	Y	
594	B(35-06) 03B00	Wells 55	523983	327,281	4,037,399	15-Jun-89													X	NONE	Energy Fuels Nuclear,	Y	
595	B(35-06) 05	Wells 55	528229	324,470	4,037,051														ME	NONE	Energy Fuels Nuclear,	Y	
596	B(35-06) 05	Wells 55	535125	324,470	4,037,051														ME	NONE	Energy Fuels Nuclear,	Y	
597	B(35-06) 05B	Wells 55	533999	324,081	4,037,466	09-Jun-92	300												ME	NONE	Energy Fuels Nuclear,	Y	
598	B(35-06) 05BD	Wells 55	528258	324,276	4,037,258	29-Aug-90													X	NONE	Energy Fuels Nuclear,	Y	
599	B(35-06) 06DD	Wells 55	528259	323,464	4,036,468														ME	NONE	Energy Fuels Nuclear,	Y	
600	B(35-06) 16	Wells 55	215677	326,018	4,033,802														ME	ME	Hillard		
601	B(35-06) 16	Wells 55	215680	326,018	4,033,802														ME	ME	Hillard		
602	B(35-06) 16AAA	Wells 55	907976	326,732	4,034,493															NONE	Hillard		
603	B(35-06) 16BB	Wells 55	528704	325,425	4,034,419	18-Sep-90													X	NONE	Energy Fuels Nuclear,	Y	
604	B(35-06) 16BBA	Wells 55	531532	325,527	4,034,518	06-Jun-91													ME	NONE	Energy Fuels Nuclear,		
605	B(35-06) 16BBA	Wells 55	535129	325,527	4,034,518	08-Jun-92	1,200												ME	NONE	Energy Fuels Nuclear,	Y	
606	B(35-07) 13	Wells 55	215366	321,210	4,033,899														ME	ME	Energy Fuel Resources		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
607	B(35-07) 13	Wells 55	507774	321,210	4,033,899	15-Sep-84													ME	NONE	Energy Fuels Nuclear,		
608	B(35-07) 13	Wells 55	511080	321,210	4,033,899														X	NONE	Energy Fuels Nuclear,	Y	
609	B(35-07) 14	Wells 55	215673	319,595	4,033,934	30-Aug-08	1,200						7						ME	ME	Energy Fuels Resources		
610	B(35-07) 14CC	Wells 55	523982	318,978	4,033,345	26-May-89													X	NONE	Energy Fuels Nuclear,	Y	
611	B(35-07) 17	Wells 55	520681	314,769	4,034,035														ME	NONE	Union Pacific Res.Co,	Y	
612	B(35-07) 20	Wells 55	520680	314,735	4,032,425														ME	NONE	Union Pacific Res.Co,	Y	
613	B(35-07) 20ADA	GWSI	362521113032601	315,501	4,032,777	01-Jan-28	460					460		5,240					X	U	Kent	Y	
614	B(35-07) 33	Wells 55	513592	316,277	4,029,173	02-Apr-87	1,645						3						X	NONE	Pathfinder Mines Crp,	Y	
615	B(35-07) 33	Wells 55	517517	316,277	4,029,173	14-Dec-87	1,410		5										ME	NONE	Pathfinder Mines Crp,	Y	
616	B(35-08) 22DBD	GWSI	362457113080001	308,660	4,032,186									7,220					W	D			
617	B(35-08) 27CBC	GWSI	362408113084601	307,481	4,030,701									7,300					W	MUN			
618	B(35-08) 31BCA	Wells 35	13989	302,977	4,029,756	01-Jan-66	600												K	X		Y	
618	B(35-08) 31BCD	GWSI	362331113114501	302,995	4,029,661	01-Oct-66	600					600		6,470					X	U	Chet Bundy	Y	
619	B(35-09) 26DAC	GWSI	362405113131501	300,777	4,030,761	01-Oct-66	670		100	100		670	6	6,410	1-Oct-66	315	6,095	10	U	U	Chet Bundy	Y	
619	B(35-09) 26DAC	Wells 35	13990	300,795	4,030,813	01-Jan-66	670									315			K	X		Y	
620	B(35-10) 22CDD	GWSI	362445113210801	289,022	4,032,273		1,164					1,164		5,240					X	U	Albert Synder	Y	D
621	B(36-04) 16AC	Wells 55	518234	345,606	4,043,328														ME	NONE	Energy Fuels Nuclear,	Y	
622	B(36-04) 21BD	Wells 55	514017	345,174	4,041,706	28-Apr-86	200						5						X	NONE	Energy Fuels Nuclear,	Y	
623	B(36-04) 21BDD	Wells 55	513075	345,272	4,041,601	05-Mar-86	1,275						4						X	NONE	Energy Fuels Nuclear,	Y	
624	B(36-04) 21C	Wells 55	511812	344,959	4,041,092	27-Nov-85													X	NONE	Energy Fuels Nuclear,	Y	
625	B(36-04) 21CBC	Wells 55	513394	344,660	4,041,201	26-Sep-86	3,200		2,524				8	5,455		2,494	2,961	11	PROD	D	Energy Fuels Nuclear,		
626	B(36-05) 04	Wells 55	507706	335,912	4,046,455														ME	NONE	Energy Fuels Nuclear,	Y	
627	B(36-05) 08	Wells 55	507702	334,271	4,044,900														ME	NONE	Energy Fuels Nuclear,	Y	
628	B(36-05) 08D	Wells 55	514723	334,665	4,044,486														ME	NONE	Energy Fuels Nuclear,	Y	
629	B(36-05) 16	Wells 55	217642	335,847	4,043,251																Uranium One USA, Inc		
630	B(36-05) 16B	Wells 55	515983	335,452	4,043,661	02-Mar-87	187						5						ME	NONE	Energy Fuels Nuclear,	Y	
631	B(36-05) 17	Wells 55	217644	334,234	4,043,285																Uranium One USA, Inc		
632	B(36-05) 19	Wells 55	217741	332,607	4,041,709																Uranium One USA, Inc		
633	B(36-05) 19B	Wells 55	509807	332,229	4,042,119														ME	NONE	Energy Fuels Nuclear,	Y	
634	B(36-05) 19B	Wells 55	520721	332,229	4,042,119	28-Jul-88	300						5						ME	NONE	Energy Fuels Nuclear,	Y	
635	B(36-05) 20	Wells 55	217643	334,188	4,041,678																Uranium One USA, Inc		
636	B(36-05) 20	Wells 55	217740	334,188	4,041,678																Uranium One USA, Inc		
637	B(36-05) 20	Wells 55	508017	334,188	4,041,678	13-Dec-84													ME	NONE	Energy Fuels Nuclear,		
638	B(36-05) 20CB	Wells 55	514633	333,582	4,041,488														ME	NONE	Energy Fuels Nuclear,	Y	
639	B(36-05) 20CC	Wells 55	510458	333,569	4,041,087														ME	NONE	Energy Fuels Nuclear,	Y	
640	B(36-05) 20CC	Wells 55	513580	333,569	4,041,087	12-May-86													X	NONE	Energy Fuels Nuclear,	Y	
641	B(36-05) 20CC	Wells 55	523965	333,569	4,041,087														ME	NONE	Energy Fuels Nuclear,	Y	
642	B(36-05) 20CC	Wells 55	539340	333,569	4,041,087														ME	NONE	Energy Fuels Nuclear,	Y	
643	B(36-05) 20CC	Wells 55	542484	333,569	4,041,087	06-Jun-94													ME	NONE	Energy Fuels Nuclear,		
644	B(36-05) 20CC	Wells 55	517181	333,569	4,041,087	09-Oct-87	1,660						5						ME	NONE	Energy Fuels Nuclear,	Y	
645	B(36-05) 21	Wells 55	217641	335,798	4,041,646																Uranium One USA, Inc		
646	B(36-05) 22	Wells 55	509640	337,410	4,041,613														ME	NONE	Energy Fuels Nuclear,	Y	
647	B(36-05) 22ADD	Wells 55	520205	338,116	4,041,703	09-Dec-88	970												G	NONE	Energy Fuels Nuclear,		
648	B(36-05) 22DD	Wells 55	510453	337,994	4,041,000														X	NONE	Energy Fuels Nuclear,	Y	
649	B(36-05) 22DD	Wells 55	511811	337,994	4,041,000														ME	NONE	Energy Fuels Nuclear,	Y	
650	B(36-05) 22DD	Wells 55	520707	337,994	4,041,000														ME	NONE	Energy Fuels Nuclear,	Y	
651	B(36-05) 23	Wells 55	509637	339,017	4,041,588														ME	NONE	Energy Fuels Nuclear,	Y	
652	B(36-05) 23BC	Wells 55	514638	338,420	4,041,798	09-Jun-86	420						5						X	NONE	Energy Fuels Nuclear,	Y	
653	B(36-05) 23BC	Wells 55	515330	338,420	4,041,798	20-Feb-87	1,387						5						ME	NONE	Energy Fuels Nuclear,	Y	
654	B(36-05) 23C	Wells 55	519304	338,601	4,041,191	30-Oct-87	180						5						ME	NONE	Energy Fuels Nuclear,	Y	
655	B(36-05) 23CBB	Wells 55	517182	338,310	4,041,497	30-Mar-87	253						5						ME	NONE	Energy Fuels Nuclear,	Y	
656	B(36-05) 25D	Wells 55	518233	340,973	4,039,536														ME	NONE	Energy Fuels Nuclear,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
657	B(36-05) 26A	Wells 55	519305	339,382	4,040,374														ME	NONE	Energy Fuels Nuclear,	Y	
658	B(36-05) 30CA	Wells 55	517322	332,365	4,039,906														ME	NONE	Energy Fuels Nuclear,	Y	
659	B(36-05) 31	Wells 55	215362	332,523	4,038,497														ME	ME	Hillard		
660	B(36-05) 31	Wells 55	909708	332,523	4,038,497																Quaterra Resources, Inc		
661	B(36-05) 32	Wells 55	214569	334,117	4,038,467	07-Apr-08	1,500												ME	ME	Quaterra Resources	Y	
662	B(36-05) 32	Wells 55	215363	334,117	4,038,467	14-Oct-07	20		20				7						ME	ME	Hillard	Y	
663	B(36-05) 32	Wells 55	215674	334,117	4,038,467														ME	ME	Hillard		
664	B(36-05) 32	Wells 55	908253	334,117	4,038,467																Hillard		
665	B(36-06) 01	Wells 55	507708	331,126	4,046,557	10-May-84													ME	NONE	Energy Fuels Nuclear,		
666	B(36-06) 05	Wells 55	508454	324,672	4,046,711														ME	NONE	Pathfinder Mines Crp,	Y	
667	B(36-06) 06B	Wells 55	217265	322,683	4,047,161																Vane Minerals (U.S.) LLC		
668	B(36-06) 15	Wells 55	213568	327,829	4,043,428														CA	MON	Quaterra Resources		
669	B(36-06) 17	Wells 55	511889	324,606	4,043,507														X	NONE	Rocky Mtn Energy,	Y	
670	B(36-06) 17	Wells 55	520928	324,606	4,043,507														ME	NONE	Union Pacific Res.Co,	Y	
671	B(36-06) 17	Wells 55	524351	324,606	4,043,507														ME	NONE	Union Pacific Res.,	Y	
672	B(36-06) 17	Wells 55	527374	324,606	4,043,507														ME	NONE	Union Pacific Resc.,	Y	
673	B(36-06) 17	Wells 55	527380	324,606	4,043,507														ME	NONE	Union Pacific Resc.,	Y	
674	B(36-06) 17	Wells 55	516101	324,606	4,043,507	23-Jul-87	1,220						5						ME	NONE	Rocky Mtn Energy,	Y	
675	B(36-06) 18	Wells 55	511892	323,009	4,043,545	18-Feb-86													X	NONE	Rocky Mtn Energy,	Y	
676	B(36-06) 18	Wells 55	524352	323,009	4,043,545	29-Apr-89													ME	NONE	Union Pacific Res.,	Y	
677	B(36-06) 18	Wells 55	520929	323,009	4,043,545	22-Jul-88	2,300						5						ME	NONE	Union Pacific Res.Co,	Y	
678	B(36-06) 18	Wells 55	527369	323,009	4,043,545	12-Sep-90	2,020						6						X	NONE	Union Pacific Resc.,	Y	
679	B(36-06) 19	Wells 55	520927	322,982	4,041,923														ME	NONE	Union Pacific Res.Co,	Y	
680	B(36-06) 19	Wells 55	524353	322,982	4,041,923														ME	NONE	Union Pacific Res.,	Y	
681	B(36-06) 19	Wells 55	527370	322,982	4,041,923														ME	NONE	Union Pacific Resc.,	Y	
682	B(36-06) 20	Wells 55	511890	324,580	4,041,887														ME	NONE	Rocky Mtn Energy,	Y	
683	B(36-06) 20	Wells 55	520700	324,580	4,041,887														ME	NONE	Union Pacific Res.Co,	Y	
684	B(36-06) 20	Wells 55	527371	324,580	4,041,887														ME	NONE	Union Pacific Resc.,	Y	
685	B(36-06) 20	Wells 55	527372	324,580	4,041,887														ME	NONE	Union Pacific Resc.,	Y	
685	B(36-06) 20	Wells 55	524354	324,580	4,041,887	27-May-89	1,920						5						ME	NONE	Union Pacific Res.,	Y	
686	B(36-06) 21DA	Wells 55	517315	326,785	4,041,633	16-Apr-87	1,718						5						ME	NONE	Energy Fuels Nuclear,	Y	
687	B(36-06) 24BC	Wells 55	510457	330,418	4,041,955														X	NONE	Energy Fuels Nuclear,	Y	
688	B(36-06) 24BC	Wells 55	513579	330,418	4,041,955	06-Apr-86													PROD	NONE	Energy Fuels Nuclear,		
689	B(36-06) 24BC	Wells 55	523984	330,418	4,041,955														ME	NONE	Energy Fuels Nuclear,	Y	
690	B(36-06) 24BC	Wells 55	528223	330,418	4,041,955	17-Aug-90													X	NONE	Energy Fuels Nuclear,	Y	
691	B(36-06) 24BC	Wells 55	539339	330,418	4,041,955														ME	NONE	Energy Fuels Nuclear,	Y	
692	B(36-06) 24BC	Wells 55	542485	330,418	4,041,955	08-Apr-94	600		600				8			420			ME	NONE	Energy Fuels Nuclear,	Y	
693	B(36-06) 26CA	Wells 55	517317	329,153	4,039,973	03-Jun-87	396						5						ME	NONE	Energy Fuels Nuclear,	Y	
694	B(36-06) 26CA	Wells 55	521583	329,153	4,039,973	26-Jul-88	410						5						ME	NONE	Energy Fuels Nuclear,	Y	
695	B(36-06) 26CA	Wells 55	523981	329,153	4,039,973	23-May-89													X	NONE	Energy Fuels Nuclear,	Y	
696	B(36-06) 29CB	Wells 55	517320	323,938	4,040,081														ME	NONE	Energy Fuels Nuclear,	Y	
697	B(36-06) 33	Wells 55	507775	326,105	4,038,627	28-Sep-84													ME	NONE	Energy Fuels Nuclear,		
698	B(36-06) 34B	Wells 55	521577	327,317	4,039,006	14-Sep-88										5		422	ME	NONE	Energy Fuels Nuclear,	Y	
699	B(36-07) 01	Wells 55	513591	321,477	4,046,771														ME	NONE	Pathfinder Mines Crp,	Y	
700	B(36-07) 01	Wells 55	520590	321,477	4,046,771	31-Mar-88													ME	NONE	Pathfinder Mines Crp,	Y	
701	B(36-07) 02	Wells 55	532071	319,866	4,046,781	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
702	B(36-07) 08	Wells 55	520679	315,007	4,045,288														ME	NONE	Union Pacific Res.Co,	Y	
703	B(36-07) 08	Wells 55	523638	315,007	4,045,288	16-May-89	1,480						5						ME	NONE	U.P.R.C.,	Y	
704	B(36-08) 10	Wells 55	521674	308,609	4,045,419	31-Jul-88													ME	NONE	Pathfinder Mines Crp,	Y	
705	B(36-9) AC	AOGC		293,915	4,040,770	01-Nov-82	5,961							6,350						DH	Gulf Oil		
706	B(37-03) 07	Wells 55	213539	351,853	4,054,128														ME	ME	Quaterra Resources		
707	B(37-03) 17	Wells 55	507709	353,418	4,052,481	10-Dec-84													ME	NONE	Energy Fuels Nuclear,		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
708	B(37-03) 17A	Wells 55	510454	353,825	4,052,880														X	NONE	Energy Fuels Nuclear,	Y	
709	B(37-03) 17A	Wells 55	512139	353,825	4,052,880														X	NONE	Energy Fuels Nuclear,	Y	
710	B(37-03) 20	Wells 55	215684	353,394	4,050,869														ME	ME	Hillard		
711	B(37-04) 06DD	Wells 55	512137	342,818	4,055,381														X	NONE	Energy Fuels Nuclear,	Y	
712	B(37-04) 06DD	Wells 55	521834	342,818	4,055,381	30-Aug-88										5		246	ME	NONE	Energy Fuels Nuclear,	Y	
713	B(37-04) 06DDD	Wells 55	514018	342,915	4,055,280	22-May-86													X	NONE	Energy Fuels Nuclear,	Y	
714	B(37-04) 10	Wells 55	907543	347,033	4,054,274															ME	Tournigan USA Inc.		
715	B(37-04) 14	Wells 55	507703	348,605	4,052,639	22-Aug-84													ME	NONE	Energy Fuels Nuclear,		
716	B(37-04) 14BD	Wells 55	519303	348,407	4,052,844	06-Nov-87	1,580						5						ME	NONE	Energy Fuels Nuclear,	Y	
717	B(37-04) 17AAC	Wells 55	520716	344,282	4,053,215	24-Aug-88	295						5						ME	NONE	Energy Fuels Nuclear,	Y	
718	B(37-04) 19CB	Wells 55	517323	341,536	4,050,975	07-Apr-87	193						5						ME	NONE	Energy Fuels Nuclear,	Y	
719	B(37-04) 24DB	Wells 55	633117	350,384	4,050,796		300						2					2	PROD	S	711 Cattle Co,		
720	B(37-05) 01	Wells 55	507704	340,643	4,056,017														ME	NONE	Energy Fuels Nuclear,	Y	
721	B(37-05) 02CC	Wells 55	512131	338,448	4,055,443														X	NONE	Energy Fuels Nuclear,	Y	
722	B(37-05) 02CC	Wells 55	512136	338,448	4,055,443														ME	NONE	Energy Fuels Nuclear,	Y	
723	B(37-05) 08DD	Wells 55	521586	334,822	4,053,917	19-Jul-88	225						5						ME	NONE	Energy Fuels Nuclear,	Y	
724	B(37-05) 13	Wells 55	908304	340,587	4,052,795																BLM		
725	B(37-05) 14	Wells 55	906606	339,012	4,052,828															NONE	Liberty Star Gold Corp.		
726	B(37-05) 14	Wells 55	908305	339,012	4,052,828																BLM		
727	B(37-05) 14BD	Wells 55	519307	338,816	4,053,031														ME	NONE	Energy Fuels Nuclear,	Y	
728	B(37-05) 14BD	Wells 55	521585	338,816	4,053,031	18-Aug-88										5		260	ME	NONE	Energy Fuels Nuclear,	Y	
729	B(37-05) 14BDD	Wells 55	510380	338,915	4,052,930														X	NONE	Energy Fuels Nuclear,	Y	
730	B(37-05) 14C	Wells 55	521574	338,607	4,052,436														ME	NONE	Energy Fuels Nuclear,	Y	
731	B(37-05) 14CA	Wells 55	519306	338,810	4,052,632														ME	NONE	Energy Fuels Nuclear,	Y	
732	B(37-05) 24AD	Wells 55	521580	341,146	4,051,382	15-Aug-88	250						5						ME	NONE	Energy Fuels Nuclear,	Y	
733	B(37-05) 26ABB	Wells 35	13995	339,067	4,050,324	17-Jun-80	1,475		40				6			1,096		5	MIN	PROD	Hack Canyon Minerals		
733	B(37-05) 26ABB	Wells 55	640855	339,067	4,050,324	17-Jun-80	1,475		40				6			1,096		5	PROD	MIN	Energy Fuels Ltd,	Y	
734	B(37-05) 27	Wells 55	509638	337,365	4,049,655	06-Dec-84													ME	NONE	Energy Fuels Nuclear,	Y	
735	B(37-05) 27D	Wells 55	509806	337,759	4,049,246														ME	NONE	Energy Fuels Nuclear,	Y	
736	B(37-05) 27D	Wells 55	510455	337,759	4,049,246														ME	NONE	Energy Fuels Nuclear,	Y	
737	B(37-05) 27D	Wells 55	511229	337,759	4,049,246														X	NONE	Energy Fuels Nuclear,	Y	
738	B(37-05) 27DA	Wells 55	510456	337,961	4,049,442														ME	NONE	Energy Fuels Nuclear,	Y	
739	B(37-05) 27DA	Wells 55	511230	337,961	4,049,442														X	NONE	Energy Fuels Nuclear,	Y	
740	B(37-05) 27DA	Wells 55	516953	337,961	4,049,442	12-Mar-87	850						5						ME	NONE	Energy Fuels Nuclear,	Y	
741	B(37-05) 27DC	Wells 55	516952	337,557	4,049,049	26-Mar-87	206						5						ME	NONE	Energy Fuels Nuclear,	Y	
742	B(37-05) 31AB	Wells 55	514634	332,757	4,048,713														ME	NONE	Energy Fuels Nuclear,	Y	
743	B(37-05) 33	Wells 55	507707	335,751	4,048,059														ME	NONE	Energy Fuels Nuclear,	Y	
744	B(37-05) 35BB	Wells 55	517184	338,348	4,048,625	28-Apr-87	277						5						ME	NONE	Energy Fuels Nuclear,	Y	
745	B(37-05) 35CB	Wells 55	519308	338,332	4,047,803	20-Nov-87	225						5						ME	NONE	Energy Fuels Nuclear,	Y	
746	B(37-05) 36AD	Wells 55	633116	341,100	4,048,156		500						2			480		1	PROD	S	711 Cattle Co,		
747	B(37-06) 01	Wells 55	517453	331,056	4,056,200														ME	NONE	Pathfinder Mines Crp,	Y	
748	B(37-06) 02	Wells 55	520754	329,445	4,056,220														ME	NONE	Pathfinder Mines Crp,	Y	
749	B(37-06) 02	Wells 55	510574	329,445	4,056,220	25-Feb-86	810												X	NONE	Pathfinder Mines Crp,	Y	
750	B(37-06) 02	Wells 55	513599	329,445	4,056,220	01-Nov-86	1,526						5						X	NONE	Pathfinder Mines Crp,	Y	
751	B(37-06) 02	Wells 55	517454	329,445	4,056,220	14-Dec-87	1,203						5						ME	NONE	Pathfinder Mines Crp,	Y	
752	B(37-06) 02DC	Wells 55	542487	329,630	4,055,623	27-Mar-94													ME	NONE	Energy Fuels Nuclear,	Y	
753	B(37-06) 03	Wells 55	507558	327,850	4,056,257	05-Aug-84													ME	NONE	Pathfinder Mines Crp,		
754	B(37-06) 03	Wells 55	520593	327,850	4,056,257														ME	NONE	Pathfinder Mines Crp,	Y	
755	B(37-06) 03	Wells 55	523717	327,850	4,056,257	01-Dec-89	151						5						ME	NONE	Pathfinder Mines Crp,	Y	
756	B(37-06) 03	Wells 55	510575	327,850	4,056,257	01-Dec-86	1,374						5						X	NONE	Pathfinder Mines Crp,	Y	
757	B(37-06) 03CD0	Wells 55	537973	327,630	4,055,665	15-Apr-93													ME	NONE	Pathfinder Mines Crp,	Y	
758	B(37-06) 09	Wells 55	508447	326,223	4,054,696	03-Aug-84													ME	NONE	Pathfinder Mines Crp,		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
759	B(37-06) 10	Wells 55	215679	327,818	4,054,658														ME	ME	Hillard		
760	B(37-06) 10	Wells 55	520595	327,818	4,054,658														ME	NONE	Pathfinder Mines Crp,	Y	
761	B(37-06) 10	Wells 55	532069	327,818	4,054,658	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
762	B(37-06) 10	Wells 55	909214	327,818	4,054,658																Quaterra Resources		
763	B(37-06) 11	Wells 55	507563	329,416	4,054,628	26-Nov-84													ME	NONE	Pathfinder Mines Crp,		
764	B(37-06) 11	Wells 55	510570	329,416	4,054,628	07-Mar-86	473												X	NONE	Pathfinder Mines Crp,	Y	
765	B(37-06) 11	Wells 55	520753	329,416	4,054,628	28-Feb-88													ME	NONE	Pathfinder Mines Crp,	Y	
766	B(37-06) 11	Wells 55	513799	329,416	4,054,628	01-Nov-86	2,328						5						X	NONE	Pathfinder Mines Crp,	Y	
767	B(37-06) 11	Wells 55	517455	329,416	4,054,628	22-Dec-87	1,207						5						ME	NONE	Pathfinder Mines Crp,	Y	
768	B(37-06) 11	Wells 55	523719	329,416	4,054,628	30-Jun-89	2,255						5						ME	NONE	Pathfinder Mines Crp,	Y	
769	B(37-06) 12	Wells 55	514130	331,021	4,054,600	01-Nov-86	1,206						5						X	NONE	Pathfinder Mines Crp,	Y	
770	B(37-06) 12	Wells 55	517456	331,021	4,054,600	22-Dec-87	1,305						5						ME	NONE	Pathfinder Mines Crp,	Y	
771	B(37-06) 14	Wells 55	513585	329,395	4,053,022	28-Feb-86	55						5						X	NONE	Pathfinder Mines Crp,	Y	
772	B(37-06) 14	Wells 55	520592	329,395	4,053,022	30-Mar-88													ME	NONE	Pathfinder Mines Crp,	Y	
773	B(37-06) 15	Wells 55	532068	327,802	4,053,060	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
774	B(37-06) 17	Wells 55	532082	324,588	4,053,119	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
775	B(37-06) 21	Wells 55	508448	326,175	4,051,483														ME	NONE	Pathfinder Mines Crp,	Y	
776	B(37-06) 22D	GWSI	363526112550501	328,351	4,051,165		700					700		5,180					UND	UND	E Jackson		
777	B(37-06) 23	Wells 55	517457	329,371	4,051,411	14-Dec-87	250						5						ME	NONE	Pathfinder Mines Crp,	Y	
778	B(37-06) 24	Wells 55	532067	330,972	4,051,378	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
779	B(37-06) 29	Wells 55	508449	324,532	4,049,909														ME	NONE	Pathfinder Mines Crp,	Y	
780	B(37-06) 29	Wells 55	510571	324,532	4,049,909														ME	NONE	Pathfinder Mines Crp,	Y	
781	B(37-06) 29	Wells 55	513597	324,532	4,049,909														ME	NONE	Pathfinder Mines Crp,	Y	
782	B(37-06) 29	Wells 55	532070	324,532	4,049,909	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
783	B(37-06) 35	Wells 55	532066	329,316	4,048,197	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
784	B(37-06) 35BC	Wells 55	514299	328,720	4,048,413	12-May-86													X	NONE	Energy Fuels Nuclear,	Y	
785	B(37-07) 01	Wells 55	507560	321,420	4,056,391	29-Sep-84													ME	NONE	Pathfinder Mines Crp,		
786	B(37-07) 01	Wells 55	534440	321,420	4,056,391														ME	NONE	Pathfinder Mines Crp,	Y	
787	B(37-07) 01	Wells 55	510573	321,420	4,056,391	11-Mar-86	1,563												X	NONE	Pathfinder Mines Crp,	Y	
788	B(37-07) 01	Wells 55	517458	321,420	4,056,391	04-Jan-88	1,160						5			187			ME	NONE	Pathfinder Mines Crp,	Y	
789	B(37-07) 02	Wells 55	534441	319,818	4,056,425														ME	NONE	Pathfinder Mines Crp,	Y	
790	B(37-07) 03	Wells 55	513590	318,204	4,056,463	19-Mar-87	470						5						X	NONE	Pathfinder Mines Crp,	Y	
791	B(37-07) 03	Wells 55	532079	318,204	4,056,463	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
792	B(37-07) 03	Wells 55	906417	318,204	4,056,463															NONE	Liberty Star Gold Corp		
793	B(37-07) 03	Wells 55	908303	318,204	4,056,463																BLM		
794	B(37-07) 04	Wells 55	520591	316,594	4,056,498	30-May-88													ME	NONE	Pathfinder Mines Crp,	Y	
795	B(37-07) 05	Wells 55	520909	314,984	4,056,536														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
796	B(37-07) 05A	Wells 55	519299	315,394	4,056,928	31-Dec-87	365												ME	NONE	Uranerz USA Inc.,	Y	
797	B(37-07) 08	Wells 55	527924	314,955	4,054,922														ME	NONE	Union Pacific Resc.,	Y	
798	B(37-07) 08	Wells 55	521207	314,955	4,054,922	13-Jun-88	2,300						5						ME	NONE	Union Pacific Res Co,	Y	
799	B(37-07) 08	Wells 55	524507	314,955	4,054,922	08-Aug-89	2,200						3						ME	NONE	Union Pacific Res.,	Y	
800	B(37-07) 09	Wells 55	510858	316,566	4,054,886														ME	NONE	Rocky Mtn Energy,	Y	
801	B(37-07) 11	Wells 55	532081	319,782	4,054,816	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
802	B(37-07) 11	Wells 55	534442	319,782	4,054,816														ME	NONE	Pathfinder Mines Crp,	Y	
803	B(37-07) 11	Wells 55	517459	319,782	4,054,816	22-Dec-87	1,304						5						ME	NONE	Pathfinder Mines Crp,	Y	
804	B(37-07) 12	Wells 55	534443	321,388	4,054,777														ME	NONE	Pathfinder Mines Crp,	Y	
805	B(37-07) 13	Wells 55	517460	321,362	4,053,180	22-Dec-87	1,204						5						ME	NONE	Pathfinder Mines Crp,	Y	
806	B(37-07) 14	Wells 55	532078	319,751	4,053,206	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
807	B(37-07) 17	Wells 55	521208	314,926	4,053,308	01-Jun-88	180						5						ME	NONE	Union Pacific Res Co,	Y	
808	B(37-07) 17	Wells 55	524508	314,926	4,053,308														ME	NONE	Union Pacific Res.,	Y	
809	B(37-07) 17	Wells 55	527926	314,926	4,053,308	28-Sep-90	2,201						3						X	NONE	Union Pacific Resc.,	Y	
810	B(37-07) 23	Wells 55	532076	319,719	4,051,598	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
811	B(37-07) 24	Wells 55	532074	321,328	4,051,573	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
812	B(37-07) 25	Wells 55	511550	321,294	4,049,970														ME	NONE	Rocky Mtn Energy,	Y	
813	B(37-07) 25	Wells 55	521913	321,294	4,049,970	24-Aug-88	300						5						ME	NONE	Union Pacific Res.,	Y	
814	B(37-07) 25	Wells 55	532077	321,294	4,049,970	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
815	B(37-07) 26	Wells 55	511545	319,686	4,049,988														ME	NONE	Rocky Mtn Energy,	Y	
816	B(37-07) 26	Wells 55	532075	319,686	4,049,988	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
817	B(37-07) 31	Wells 55	532072	313,216	4,048,520	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
818	B(37-07) 32	Wells 55	511549	314,824	4,048,485														ME	NONE	Rocky Mtn Energy,	Y	
819	B(37-07) 32	Wells 55	519206	314,824	4,048,485	31-Dec-87	365												ME	NONE	Uranerz USA Inc.,	Y	
820	B(37-07) 36	Wells 55	532073	321,264	4,048,372	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
821	B(37-08) 01	Wells 55	510860	311,782	4,056,607														ME	NONE	Rocky Mtn Energy,	Y	
822	B(37-08) 03	Wells 55	510049	308,562	4,056,670														ME	NONE	Pathfinder Mines Crp,	Y	
823	B(37-09) 27	Wells 55	520687	298,779	4,050,467	04-May-88	2,180						5						ME	NONE	Union Pacific Res.Co,	Y	
824	B(37-09) 27	Wells 55	520701	298,779	4,050,467	03-May-88	2,040						5						ME	NONE	Union Pacific Res.Co,	Y	
825	B(37-09) 27	Wells 55	524504	298,779	4,050,467	13-Aug-89	1,620						5						ME	NONE	Union Pacific Res.,	Y	
826	B(37-10) 07	Wells 55	520350	284,444	4,055,685	30-Jul-88	1,200						5						ME	NONE	U.P.R.C.,	Y	
827	B(37-11) 24	Wells 55	515537	282,750	4,052,515	19-Sep-86	1,310						5						X	NONE	Rocky Mtn Energy,	Y	
828	B(37-9) DD	AOGC		294,564	4,053,337	01-Jan-99	3,617							4,925						TA	Premco Western		
829	B(38-01) 05	Wells 55	507929	372,936	4,064,958	03-Sep-84													ME	NONE	Pathfinder Mines Crp,		
830	B(38-01) 06	Wells 55	507928	371,345	4,064,985	03-Sep-84													ME	NONE	Pathfinder Mines Crp,		
831	B(38-02) 05	Wells 55	507942	363,255	4,065,157														ME	NONE	Energy Fuels Nuclear,	Y	
832	B(38-02) 05ABB	Wells 55	503711	363,373	4,065,856	03-Sep-82	2,350		560				6	5,409		1,736	3,673	10	X	D	Energy Fuels Ltd,	Y	
833	B(38-02) 30	Wells 55	513602	361,575	4,058,759														ME	NONE	Pathfinder Mines Crp,	Y	
834	B(38-03) 02	Wells 55	508458	358,494	4,065,289														ME	NONE	Pathfinder Mines Crp,	Y	
835	B(38-03) 02	Wells 55	510436	358,494	4,065,289	28-Feb-86	1,000						6						X	NONE	Pathfinder Mines Crp,	Y	
836	B(38-03) 02	Wells 55	514738	358,494	4,065,289	01-Oct-86	1,000						5						X	NONE	Pathfinder Mines Crp,	Y	
837	B(38-03) 05	Wells 55	508453	353,665	4,065,376	22-Sep-84													ME	NONE	Pathfinder Mines Crp,		
838	B(38-03) 05	Wells 55	517461	353,665	4,065,376	04-Jan-88	460						2						ME	NONE	Pathfinder Mines Crp,	Y	
839	B(38-03) 05	Wells 55	510439	353,665	4,065,376	28-Feb-86	1,164		6										X	NONE	Pathfinder Mines Crp,	Y	
840	B(38-03) 05	Wells 55	513601	353,665	4,065,376	01-Nov-86	1,425		5										X	NONE	Pathfinder Mines Crp,	Y	
841	B(38-03) 05CD	Wells 55	512132	353,455	4,064,756														X	NONE	Energy Fuels Nuclear,	Y	
842	B(38-03) 06	Wells 55	215678	352,066	4,065,405														ME	ME	Hillard		
843	B(38-03) 11	Wells 55	508848	358,462	4,063,653	26-Sep-84	950												PZ	NONE	Pathfinder Mines Crp,		
844	B(38-03) 11DC	Wells 55	518230	358,652	4,063,046	24-Jul-87	280						5						ME	NONE	Energy Fuels Nuclear,	Y	
845	B(38-03) 17BB	Wells 55	517316	353,021	4,062,745	01-May-87	105												ME	NONE	Energy Fuels Nuclear,	Y	
846	B(38-03) 17CAA	Wells 55	504759	353,509	4,062,033														PROD	D	Energy Fuels Ltd,	Y	
847	B(38-03) 17CCA	Wells 55	509198	353,099	4,061,639	05-Nov-84	2,700		860				8	5,018		1,470	3,548	10	PROD	D	Energy Fuels Ltd,		
848	B(38-03) 20CB	Wells 55	531703	352,977	4,060,330	31-Oct-91													ME	NONE	Energy Fuels Nuclear,		
849	B(38-03) 20CB	Wells 55	535130	352,977	4,060,330	07-Oct-92													ME	NONE	Energy Fuels Nuclear,	Y	
850	B(38-03) 20CB	Wells 55	539703	352,977	4,060,330	30-Dec-93													ME	NONE	Energy Fuels Nuclear,	Y	
851	B(38-03) 20CB	Wells 55	542482	352,977	4,060,330	06-Jan-94													ME	NONE	Energy Fuels Nuclear,	Y	
852	B(38-03) 20CB	Wells 55	517183	352,977	4,060,330	05-Apr-87	890						5						ME	NONE	Energy Fuels Nuclear,	Y	
853	B(38-03) 21AAC	Wells 55	531702	355,690	4,060,992														ME	NONE	Energy Fuels Nuclear,	Y	
854	B(38-04) 04B	Wells 55	517325	345,217	4,065,950	17-Jul-87	150						5						ME	NONE	Energy Fuels Nuclear,	Y	
855	B(38-04) 11BB	Wells 55	521832	348,215	4,064,464														ME	NONE	Energy Fuels Nuclear,	Y	
856	B(38-04) 13	Wells 55	516108	350,394	4,062,201	04-Mar-87	1,450						5						ME	NONE	Energy Fuels Nuclear,	Y	
857	B(38-04) 13ADB	Wells 55	217144	350,908	4,062,492																Uranium One USA, Inc	Y	
858	B(38-04) 13BC	Wells 55	509808	349,783	4,062,416	21-Dec-84													ME	NONE	Energy Fuels Nuclear,	Y	
859	B(38-04) 13BC	Wells 55	523986	349,783	4,062,416	30-Mar-89													X	NONE	Energy Fuels Nuclear,	Y	
860	B(38-04) 13BC	Wells 55	539342	349,783	4,062,416	30-Nov-93													ME	NONE	Energy Fuels Nuclear,	Y	
861	B(38-04) 13BC	Wells 55	542480	349,783	4,062,416	28-Apr-94													ME	NONE	Energy Fuels Nuclear,	Y	
862	B(38-04) 13CA	Wells 55	528226	350,185	4,062,005	09-Sep-90													X	NONE	Energy Fuels Nuclear,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
863	B(38-04) 13CA	Wells 55	531533	350,185	4,062,005	05-Aug-91													ME	NONE	Energy Fuels Nuclear,		
864	B(38-04) 13CA	Wells 55	536761	350,185	4,062,005	04-Dec-92													ME	NONE	Energy Fuels Nuclear,	Y	
865	B(38-04) 13CA	Wells 55	542486	350,185	4,062,005	07-May-94													ME	NONE	Energy Fuels Nuclear,	Y	
866	B(38-04) 13CA	Wells 55	523985	350,185	4,062,005	06-Apr-89	1,295						5						X	NONE	Energy Fuels Nuclear,	Y	
867	B(38-04) 13DC	Wells 55	519193	350,587	4,061,592	04-Nov-87	295						5						ME	NONE	Energy Fuels Nuclear,	Y	
868	B(38-04) 14	Wells 55	217493	348,771	4,062,237																Uranium One USA, Inc	Y	
869	B(38-04) 15	Wells 55	213540	347,164	4,062,271														ME	ME	Quaterra Resources		
870	B(38-04) 16ACB	Wells 55	533127	345,664	4,062,609	08-Nov-91													ME	NONE	Energy Fuels Nuclear,		
871	B(38-04) 16ACB	Wells 55	535127	345,664	4,062,609														ME	NONE	Energy Fuels Nuclear,	Y	
872	B(38-04) 17AD	Wells 55	517318	344,566	4,062,534	09-May-87	180						5						ME	NONE	Energy Fuels Nuclear,	Y	
873	B(38-04) 17BC	Wells 55	517319	343,398	4,062,581	12-May-87	190						5						ME	NONE	Energy Fuels Nuclear,	Y	
874	B(38-04) 17C	Wells 55	511992	343,581	4,061,970	13-Oct-86	1,407						5						X	NONE	Energy Fuels Nuclear,	Y	
875	B(38-04) 17CCA	Wells 55	503919	343,482	4,061,874	16-Sep-82	660		60				6						PROD	MON	Energy Fuels Nuclear,	Y	
876	B(38-04) 17CCA	Wells 55	517832	343,482	4,061,874	19-Aug-87	975						9						PROD	D	Energy Fuels Nuclear,	Y	
877	B(38-04) 17CCA	Wells 55	518877	343,482	4,061,874	12-Jan-88	3,030		1,796				10			1,513		15	PROD	S	Silver Arrow Stone Co. LLC		
877	B(38-04) 17CCA	GWSI	364123112450501	343,463	4,061,882	12-Jan-88	3,030		20	1,796	3,030	3,030	10	4,886					U	U	Energy Fuels Nuclear,Inc	Y	D
877	B(38-04) 17CCA	GWSI	364123112450501	343,463	4,061,882	12-Jan-88	3,030		970	1,796	3,030	3,030	8.62	4,886					U	U	Energy Fuels Nuclear,Inc	Y	D
877	B(38-04) 17CCA	GWSI	364123112450501	343,463	4,061,882	12-Jan-88	3,030		1,796	1,796	3,030	3,030	5.5	4,886					U	U	Energy Fuels Nuclear,Inc	Y	D
877	B(38-04) 17CCA	GWSI	364123112450501	343,463	4,061,882	12-Jan-88	3,030			1,796	3,030	3,030		4,886					U	U	Energy Fuels Nuclear,Inc	Y	D
878	B(38-04) 23	Wells 55	516499	348,747	4,060,625	12-Jun-87	1,920						5						ME	NONE	Energy Fuels Nuclear,	Y	
879	B(38-04) 30AC	Wells 55	514635	342,533	4,059,375														ME	NONE	Energy Fuels Nuclear,	Y	
880	B(38-04) 30AC	Wells 55	517321	342,533	4,059,375														ME	NONE	Energy Fuels Nuclear,	Y	
881	B(38-04) 30AC	Wells 55	520718	342,533	4,059,375	04-Aug-88	248						5						ME	NONE	Energy Fuels Nuclear,	Y	
882	B(38-04) 36C	Wells 55	517324	349,895	4,056,979	19-May-87	100						5						ME	NONE	Energy Fuels Nuclear,	Y	
883	B(38-04) 36CD	Wells 55	510382	350,094	4,056,774														X	NONE	Energy Fuels Nuclear,	Y	
884	B(38-05) 08	Wells 55	520906	334,365	4,064,159	16-Aug-88	1,900						6						ME	NONE	Uranerz, U.S.A. Inc.,	Y	
885	B(38-05) 12BB	Wells 55	512138	340,230	4,064,649														X	NONE	Energy Fuels Nuclear,	Y	
886	B(38-05) 13	Wells 55	213619	340,787	4,062,429	01-Apr-07													ME	ME	Quaterra Resources		
887	B(38-05) 17BC	Wells 55	514298	333,731	4,062,763	20-May-86													X	NONE	Energy Fuels Nuclear,	Y	
888	B(38-05) 18A	Wells 55	517665	333,156	4,062,974	20-May-87	6,405		20										ME	NONE	Uranerz, USA, Inc.,	Y	
889	B(38-05) 19	Wells 55	518349	332,740	4,060,978	14-Dec-87	1,304						5						ME	NONE	Pathfinder Mines Crp,	Y	
890	B(38-05) 20	Wells 55	520594	334,302	4,060,946														ME	NONE	Pathfinder Mines Crp,	Y	
891	B(38-05) 24CC	Wells 55	535126	340,138	4,060,225														ME	NONE	Energy Fuels Nuclear,	Y	
892	B(38-05) 24CC	Wells 55	538992	340,138	4,060,225	25-May-93													ME	NONE	Energy Fuels Nuclear,	Y	
893	B(38-05) 29	Wells 55	909827	334,269	4,059,342																Quaterra Alaska, Inc.		
894	B(38-05) 29	Wells 55	518351	334,269	4,059,342	04-Jan-88	1,202						5						ME	NONE	Pathfinder Mines Crp,	Y	
895	B(38-05) 31	Wells 55	521176	332,655	4,057,778														ME	NONE	Pathfinder Mines Crp,	Y	
896	B(38-05) 36ADD	GWSI	363905112462501	341,399	4,057,666		470					470	6.62	4,990	11-Aug-76	427	4,563		U	U	ASLD		
896	B(38-05) 36ADD	Wells 55	614912	341,391	4,057,686		471						6					5	PROD	S	ASLD		
897	B(38-05)31	GWSI	363902112522001	332,581	4,057,741		4,663					4,663		5,040					OG	U		Y	
898	B(38-06) 03A	Wells 55	517667	328,456	4,066,284	19-May-87	440						5						ME	NONE	Uranerz USA Inc,	Y	
899	B(38-06) 09D	Wells 55	520910	326,804	4,063,915														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
900	B(38-06) 12	Wells 55	519298	331,243	4,064,216														ME	NONE	Uranerz, U.S.A. Inc,	Y	
901	B(38-06) 12	Wells 55	520907	331,243	4,064,216														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
902	B(38-06) 13	Wells 55	520908	331,208	4,062,613	01-Sep-88	20												ME	NONE	Uranerz, U.S.A. Inc.,	Y	
903	B(38-06) 22	Wells 55	525094	327,954	4,061,072	28-Jul-89	1,860						5						ME	NONE	Union Pacific Res.,	Y	
904	B(38-06) 23	Wells 55	525093	329,560	4,061,042														ME	NONE	Union Pacific Res.,	Y	
905	B(38-06) 23	Wells 55	532065	329,560	4,061,042	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
906	B(38-06) 23	Wells 55	513146	329,560	4,061,042	16-Nov-86	2,120						5						X	NONE	Rocky Mtn Energy,	Y	
907	B(38-06) 23	Wells 55	517657	329,560	4,061,042	30-Jun-87	1,160						5						ME	NONE	Rocky Mtn Energy,	Y	
908	B(38-06) 23	Wells 55	520695	329,560	4,061,042	07-Apr-88	2,240						5						ME	NONE	Union Pacific Res.Co,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
909	B(38-06) 24	Wells 55	514639	331,170	4,061,010														ME	NONE	Rocky Mtn Energy,	Y	
910	B(38-06) 24	Wells 55	518348	331,170	4,061,010	14-Dec-87	280						5						ME	NONE	Pathfinder Mines Crp,	Y	
911	B(38-06) 24B	Wells 55	217268	330,777	4,061,420																Vane Minerals (U.S.) LLC		
912	B(38-06) 25	Wells 55	517462	331,136	4,059,405	14-Dec-87	1,350						5						ME	NONE	Pathfinder Mines Crp,	Y	
913	B(38-06) 25DC	Wells 55	537972	331,326	4,058,800	21-Apr-93													ME	NONE	Pathfinder Mines Crp,	Y	
914	B(38-06) 26	Wells 55	518350	329,523	4,059,433														ME	NONE	Pathfinder Mines Crp,	Y	
915	B(38-06) 28	Wells 55	513596	326,318	4,059,488	01-Nov-86	1,355		5										X	NONE	Pathfinder Mines Crp,	Y	
916	B(38-06) 28CC	Wells 55	519309	325,705	4,058,899	10-Dec-87	1,340						5						ME	NONE	Energy Fuels Nuclear,	Y	
917	B(38-06) 28DC	Wells 55	511991	326,505	4,058,880														ME	NONE	Energy Fuels Nuclear,	Y	
918	B(38-06) 28DC	Wells 55	523976	326,505	4,058,880														ME	NONE	Energy Fuels Nuclear,	Y	
919	B(38-06) 28DC	Wells 55	533128	326,505	4,058,880	02-Nov-91													ME	NONE	Energy Fuels Nuclear,		
920	B(38-06) 28DC	Wells 55	538112	326,505	4,058,880	12-May-93													ME	NONE	Energy Fuels Nuclear,	Y	
921	B(38-06) 28DC	Wells 55	521581	326,505	4,058,880	11-Jul-88	1,580						5						ME	NONE	Energy Fuels Nuclear,	Y	
922	B(38-06) 28DD	Wells 55	512140	326,905	4,058,871														X	NONE	Energy Fuels Nuclear,	Y	
923	B(38-06) 29	Wells 55	508451	324,710	4,059,524														ME	NONE	Pathfinder Mines Crp,	Y	
924	B(38-06) 29	Wells 55	510576	324,710	4,059,524														ME	NONE	Pathfinder Mines Crp,	Y	
925	B(38-06) 32	Wells 55	508450	324,679	4,057,920														ME	NONE	Pathfinder Mines Crp,	Y	
926	B(38-06) 33	Wells 55	513595	326,285	4,057,880														ME	NONE	Pathfinder Mines Crp,	Y	
927	B(38-06) 35	Wells 55	508455	329,492	4,057,824	29-Sep-84													ME	NONE	Pathfinder Mines Crp,		
928	B(38-06) 35	Wells 55	513594	329,492	4,057,824	01-Nov-86	1,205						5						X	NONE	Pathfinder Mines Crp,	Y	
929	B(38-06) 35	Wells 55	517463	329,492	4,057,824	22-Dec-87	1,504						5						ME	NONE	Pathfinder Mines Crp,	Y	
930	B(38-06) 36	Wells 55	508452	331,100	4,057,797														ME	NONE	Pathfinder Mines Crp,	Y	
931	B(38-06) 36	Wells 55	520750	331,100	4,057,797	30-Mar-88													ME	NONE	Pathfinder Mines Crp,	Y	
932	B(38-06) 36	Wells 55	513593	331,100	4,057,797	01-Nov-86	520						5						X	NONE	Pathfinder Mines Crp,	Y	
933	B(38-06) 36	Wells 55	517464	331,100	4,057,797	04-Jan-88	1,130		5										ME	NONE	Pathfinder Mines Crp,	Y	
934	B(38-06) 36	Wells 55	523718	331,100	4,057,797	30-Sep-89	1,510						5						ME	NONE	Pathfinder Mines Crp,	Y	
935	B(38-07) 05	Wells 55	511886	315,185	4,066,187														X	NONE	Rocky Mtn Energy,	Y	
936	B(38-07) 05	Wells 55	514640	315,185	4,066,187	07-Nov-86	1,360						5						X	NONE	Rocky Mtn Energy,	Y	
937	B(38-07) 05ACC	GWSI	364327113040601	315,225	4,066,268		25					25		4,880	5-Aug-50	18	4,862		W	S	Lee Esplin		
938	B(38-07) 05ACC	GWSI	364328113040501	315,250	4,066,298			3					36	4,875	9-Aug-76	15	4,860		W	S	Lee Esplin		
939	B(38-07) 05BDD	GWSI	364328113040801	315,176	4,066,300		23					23		4,870	9-Aug-76	17	4,853		U	U		Y	
940	B(38-07) 05DB	Wells 55	642992	315,383	4,065,981	01-Jan-34	21		21				48			17		10	PROD	S	Heaton Cattlle Company		
941	B(38-07) 05DB	Wells 55	642993	315,383	4,065,981	01-Jan-60	30		30				6			25		5	PROD	S	Heaton Cattlle Company		
942	B(38-07) 06	Wells 55	511887	313,583	4,066,227	11-Feb-86							60			40			X	NONE	Rocky Mtn Energy,	Y	
943	B(38-07) 06	Wells 55	514641	313,583	4,066,227														ME	NONE	Rocky Mtn Energy,	Y	
944	B(38-07) 07	Wells 55	511547	313,549	4,064,616	12-Feb-86													X	NONE	Rocky Mtn Energy,	Y	
945	B(38-07) 07	Wells 55	525095	313,549	4,064,616														ME	NONE	Union Pacific Res.,	Y	
946	B(38-07) 07	Wells 55	514642	313,549	4,064,616	19-Sep-86	1,515						5						X	NONE	Rocky Mtn Energy,	Y	
947	B(38-07) 07	Wells 55	520353	313,549	4,064,616	24-Mar-88	2,290						5						ME	NONE	U.P.R.C.,	Y	
948	B(38-07) 08	Wells 55	511888	315,152	4,064,580														ME	NONE	Rocky Mtn Energy,	Y	
949	B(38-07) 08	Wells 55	514643	315,152	4,064,580	19-Sep-86	1,520						5						X	NONE	Rocky Mtn Energy,	Y	
950	B(38-07) 11AC	Wells 55	525268	320,184	4,064,670	26-Jul-89													X	NONE	Energy Fuels Nuclear,	Y	
951	B(38-07) 16DBA	Wells 55	642990	317,023	4,062,826	01-Jan-65	30		30				6			21		5	PROD	S	Heaton Cattlle Company		
951	B(38-07) 16DDB	GWSI	364127113023901	317,304	4,062,523		30	2				30	6	4,928					W	S	Esplin Cattle Co		
952	B(38-07) 17CCC	GWSI	364117113043401	314,443	4,062,276		1,780					1,780		4,970					OG	U		Y	G
953	B(38-07) 18	Wells 55	511548	313,516	4,063,009														ME	NONE	Rocky Mtn Energy,	Y	
954	B(38-07) 18	Wells 55	513589	313,516	4,063,009														ME	NONE	Pathfinder Mines Crp,	Y	
955	B(38-07) 18	Wells 55	520751	313,516	4,063,009	30-Jun-88													ME	NONE	Pathfinder Mines Crp,	Y	
956	B(38-07) 18	Wells 55	523568	313,516	4,063,009	16-Mar-89	440						5						ME	NONE	Union Pacific Res Co,	Y	
957	B(38-07) 18	Wells 55	527381	313,516	4,063,009	16-Jun-90	2,120						5						ME	NONE	Union Pacific Resc.,		
958	B(38-07) 18D	Wells 55	217267	313,906	4,062,598																Vane Minerals (U.S.) LLC		
959	B(38-07) 27	Wells 55	908301	318,269	4,059,682																BLM		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
960	B(38-07) 28	Wells 55	519205	316,659	4,059,719														ME	NONE	Uranerz USA Inc.,	Y	
961	B(38-07) 28D	Wells 55	522046	317,053	4,059,307	23-Aug-88	340						6						ME	NONE	Uranerz U.S.A. Inc,	Y	
962	B(38-07) 29	Wells 55	519204	315,049	4,059,754														ME	NONE	Uranerz USA Inc.,	Y	
963	B(38-07) 29ABB	GWSI	364019113040201	315,199	4,060,472	01-Jul-70	1,115	2				1,115	14	4,985					OG	U		Y	G
963	B(38-07) 29ABB	GWSI	364019113040201	315,199	4,060,472	01-Jul-70	1,115	6				1,115	4.5	4,985					OG	U		Y	G
964	B(38-07) 31	Wells 55	510859	313,416	4,058,179														ME	NONE	Rocky Mtn Energy,	Y	
965	B(38-07) 33A	Wells 55	522045	317,036	4,058,503	18-Aug-88	350						6						ME	NONE	Uranerz U.S.A Inc,	Y	
966	B(38-07) 34	Wells 55	507559	318,236	4,058,071	29-Sep-84													ME	NONE	Pathfinder Mines Crp,		
967	B(38-07) 34	Wells 55	517465	318,236	4,058,071														ME	NONE	Pathfinder Mines Crp,	Y	
968	B(38-07) 34	Wells 55	906418	318,236	4,058,071															ME	Liberty Star Gold Corp		
969	B(38-07) 34	Wells 55	908302	318,236	4,058,071																BLM		
970	B(38-07) 34	Wells 55	510572	318,236	4,058,071	17-Mar-86	2,106						6						X	NONE	Pathfinder Mines Crp,	Y	
971	B(38-07) 34CBB	Wells 55	642991	317,529	4,057,988	01-Jan-65	80		80				6			60		10	PROD	S	Heaton Cattlle Company		
971	B(38-07) 34CBB	GWSI	363902113022601	317,532	4,058,048		80	2				80	8	5,005					W	S	Esplin Cattle Co		
972	B(38-07) 35	Wells 55	532080	319,849	4,058,033	30-Nov-91													ME	NONE	Pathfinder Mines Crp,		
973	B(38-07) 35DBD	GWSI	363853113004001	320,159	4,057,715									5,000					U	U	Lee Esplin	Y	
974	B(38-08) 01	Wells 55	513588	311,984	4,066,264														ME	NONE	Pathfinder Mines Crp,	Y	
975	B(38-08) 03AA	Wells 55	518920	309,382	4,066,925	09-Oct-87	310						5						ME	NONE	Energy Fuels Nuclear,	Y	
976	B(38-08) 12	Wells 55	513587	311,949	4,064,653														ME	NONE	Pathfinder Mines Crp,	Y	
977	B(38-08) 13	Wells 55	511546	311,916	4,063,043														ME	NONE	Rocky Mtn Energy,	Y	
978	B(38-08) 13	Wells 55	513586	311,916	4,063,043	01-Nov-86	1,306						5						X	NONE	Pathfinder Mines Crp,	Y	
979	B(38-08) 22	Wells 55	525088	308,664	4,061,496														ME	NONE	Union Pacific Res.,	Y	
980	B(38-08) 22	Wells 55	516102	308,664	4,061,496	23-Jul-87	1,220						5						ME	NONE	Rocky Mtn Energy,	Y	
981	B(38-08) 22	Wells 55	520317	308,664	4,061,496	24-Feb-88	2,010						5						ME	NONE	U.P.R.C.,	Y	
982	B(38-08) 22	Wells 55	520351	308,664	4,061,496	21-Feb-88	2,020						5						ME	NONE	U.P.R.C.,	Y	
983	B(38-08) 26	Wells 55	520587	310,241	4,059,856	30-Mar-88													ME	NONE	Pathfinder Mines Crp,	Y	
984	B(38-08) 27	Wells 55	521730	308,630	4,059,886		200						5						ME	NONE	U.P.R.C.,	Y	
985	B(38-08) 27	Wells 55	523639	308,630	4,059,886														ME	NONE	U.P.R.C.,	Y	
986	B(38-08) 27	Wells 55	525092	308,630	4,059,886	14-Jun-90	1,140						5						ME	NONE	Union Pacific Res.,		
987	B(38-08) 28	Wells 55	525091	307,020	4,059,925														ME	NONE	Union Pacific Res.,	Y	
988	B(38-08) 34	Wells 55	520589	308,596	4,058,278														ME	NONE	Pathfinder Mines Crp,	Y	
989	B(38-10) 27	Wells 55	520348	289,388	4,060,440	14-Jun-88	2,020						5						ME	NONE	U.P.R.C.,	Y	
990	B(38-10) 36	Wells 55	520349	292,563	4,058,749	27-May-88	1,640						5						ME	NONE	U.P.R.C.,	Y	
991	B(38-10) CA	AOGC		286,438	4,063,917	01-Jun-80	3,125							4,565						DH	Home Petroleum		
992	B(38-5) BD	AOGC		332,821	4,057,541	01-May-58	4,666							5,052						DH	Western Drlg/Valen		
993	B(38-7) BA	AOGC		315,185	4,060,445	01-Jul-70	1,115							4,985						DH	Harris, James J.		
994	B(38-7) BC	AOGC		314,512	4,062,875	01-Oct-60	32							4,985						DH	Fields, Roger A.		
995	B(38-7) CC	AOGC		314,423	4,062,281	01-Jun-57	460							4,976						DH	Fields, Roger A.		
996	B(38-7) CC	AOGC		314,430	4,062,282	01-Apr-58	1,780							4,972						DH	Fields, Roger A.		
997	B(39-01) 08D	Wells 55	217269	373,425	4,072,616																Vane Minerals (U.S.) LLC		
998	B(39-01) 18CBA	Wells 55	535436	370,912	4,071,339														ME	NONE	Energy Fuels Nuclear,	Y	
999	B(39-01) 18DD	Wells 55	637621	371,999	4,070,820	28-Aug-69	690		28				10			489		4	PROD	S	BLM-AZ Strip Dist,		
999	B(39-01) 18DDB	GWSI	364632112261001	371,908	4,070,820	12-Aug-69	690					690	12.62	5,585	25-Oct-07	485	5,100	3	W	S	BLM		
1000	B(39-01) 22BCA	GWSI	364607112233001	375,731	4,070,107	01-Jan-56	523		38	38	523	523	8	5,840					W	S	Dj Kloefer R L Hunt		D
1000	B(39-01) 22BDB	Wells 55	602855	375,910	4,070,066	01-Jan-56	523		38				8			518		5	PROD	I	Russel L Hunt,		
1000	B(39-01) 22BDB	Wells 35	13998	375,910	4,070,066	01-Mar-56	523		38				8			518		2	I	PROD	Kloepfer & Hunt		
1001	B(39-01) 22BDC	Wells 35	13999	375,907	4,069,865	15-Jun-60	550		500				4			500		15	S	PROD	Webb		
1002	B(39-01) 30	Wells 55	507927	371,384	4,068,206	08-Sep-84													ME	NONE	Pathfinder Mines Crp,		
1003	B(39-01) 30	Wells 55	510437	371,384	4,068,206	28-Feb-86	900						6						X	NONE	Pathfinder Mines Crp,	Y	
1004	B(39-01) 30	Wells 55	514737	371,384	4,068,206	01-Nov-86	900						5						X	NONE	Pathfinder Mines Crp,	Y	
1005	B(39-02) 20CD	Wells 55	805803	363,130	4,069,378	30-Apr-74	700		20				8			650		5	PROD	S	Orton, John,		
1006	B(39-02) 20CDD	GWSI	364540112315501	363,157	4,069,273									5,272	25-Oct-07	611	4,662		W	S			

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1007	B(39-02) 30B	Wells 55	528234	361,362	4,068,807														ME	NONE	Energy Fuels Nuclear,	Y	
1008	B(39-02) 30B	Wells 55	535123	361,362	4,068,807														ME	NONE	Energy Fuels Nuclear,	Y	
1009	B(39-02) 32BC	Wells 55	523987	362,677	4,066,974														ME	NONE	Energy Fuels Nuclear,	Y	
1010	B(39-02) 32C	Wells 55	523943	362,873	4,066,368	15-May-89													X	NONE	Energy Fuels Nuclear,	Y	
1011	B(39-02) 36	Wells 55	510438	369,754	4,066,639	28-Feb-86	900						6						X	NONE	Pathfinder Mines Crp,	Y	
1012	B(39-03) 06	Wells 55	213618	352,243	4,075,109														ME	ME	Quaterra Resources		
1013	B(39-03) 06AB0	Wells 55	644762	352,447	4,075,701	01-Jan-54	65		40				10			30		5	PROD	S	Heaton,F E		
1014	B(39-03) 11C	Wells 55	521582	358,224	4,072,979														ME	NONE	Energy Fuels Nuclear,	Y	
1015	B(39-03) 13DDC	Wells 55	535437	360,718	4,071,011														ME	NONE	Energy Fuels Nuclear,	Y	
1016	B(39-03) 22CD	Wells 55	512135	356,758	4,069,592	04-Feb-86													X	NONE	Energy Fuels Nuclear,	Y	
1017	B(39-03) 24	Wells 55	508846	360,198	4,070,121	15-Sep-84													ME	NONE	Pathfinder Mines Crp,		
1018	B(39-03) 26	Wells 55	508457	358,551	4,068,547	15-Sep-84													ME	NONE	Pathfinder Mines Crp,		
1019	B(39-03) 28	Wells 55	515014	355,330	4,068,607	01-Nov-86	1,010						5						X	NONE	Pathfinder Mines Crp,	Y	
1020	B(39-03) 29	Wells 55	508847	353,722	4,068,635	22-Sep-84													ME	NONE	Pathfinder Mines Crp,		
1021	B(39-03) 30ACB	Wells 55	533067	352,232	4,068,967	26-Sep-91													ME	NONE	Energy Fuels Nuclear,		
1022	B(39-03) 30DBB	Wells 55	533068	352,222	4,068,557														ME	NONE	Energy Fuels Nuclear,	Y	
1023	B(39-03) 31	Wells 55	215675	352,093	4,067,037														ME	ME	Hillard		
1024	B(39-03) 32AA	Wells 55	521831	354,305	4,067,604														ME	NONE	Energy Fuels Nuclear,	Y	
1025	B(39-03) 35	Wells 55	508849	358,521	4,066,928														ME	NONE	Pathfinder Mines Crp,	Y	
1026	B(39-04) 05CC	Wells 55	624437	343,607	4,074,646	01-Dec-74	65		22				6			58			PROD	S	Heaton, Alan & Rosa,	Y	
1027	B(39-04) 05CCC	GWSI	364812112451501	343,446	4,074,491	01-Mar-75	60		24			60	6	4,650	8-Sep-76	32	4,618		W	S	ASLD		
1027	B(39-04) 05CCC	Wells 35	14000	343,506	4,074,547	01-Mar-75	60		24				6			30					Heaton		
1027	B(39-04) 05CCC	Wells 55	614913	343,506	4,074,547	01-Mar-75	60		24				6			33					ASLD		
1028	B(39-04) 06D	Wells 55	649625	343,020	4,074,861	01-Nov-66	60		20				2			60		55	PROD	S	Brinkerhoff,A G		
1029	B(39-04) 11BBB	Wells 55	621239	348,323	4,074,265	01-Jan-48	110		100				4			90		15	PROD	S	Heaton Et Al,I M		
1030	B(39-04) 21	Wells 55	213621	345,726	4,070,384	04-Apr-07	507						6						ME	ME	Quaterra Resources		
1031	B(39-04) 23	Wells 55	213470	348,959	4,070,332														ME	ME	Quaterra Resources		
1032	B(39-04) 24AD	Wells 55	517314	351,177	4,070,504	14-May-87	250						5						ME	NONE	Energy Fuels Nuclear,	Y	
1033	B(39-04) 24DBD	GWSI	364550112401201	350,879	4,069,980	01-Apr-51	400		20	20	400	400	8	4,660	1-Apr-51	375	4,285		W	S	Val Jackson		
1034	B(39-04) 28	Wells 55	213620	345,695	4,068,765														ME	ME	Quaterra Resources		
1035	B(39-04) 31BCD	Wells 35	14001	341,984	4,067,330	01-Apr-51	130		32				6			18		3	S	PROD	Heaton		
1035	B(39-04) 31BCD	GWSI	364422112461201	341,902	4,067,429	01-Apr-51	130	2	32	32	130	130	6.37	4,675	11-Aug-76	22	4,653	3	U	U	Nora Heaton	Y	
1036	B(39-04) 31CCB	Wells 55	547993	341,764	4,066,731	15-Apr-95	100												PROD	S	BLM,		
1037	B(39-04) 35DBB	Wells 55	520715	348,985	4,066,990	31-Aug-88													ME	NONE	Energy Fuels Nuclear,		
1038	B(39-04) 35DDB	Wells 55	520717	349,379	4,066,582	06-Sep-88	410						5						ME	NONE	Energy Fuels Nuclear,	Y	
1039	B(39-05) 03ABA	GWSI	364858112485101	338,119	4,076,008	01-Jan-25	45		45			45	48	4,810	1-Jan-25	40	4,770		W	D	Bruce Mc Danniel		
1039	B(39-05) 03ABB	Wells 55	637322	337,917	4,076,067	21-Oct-48	40		40				48			32		8	PROD	I	Mcdaniel, Bruce,		
1040	B(39-05) 03BBC	GWSI	364851112493601	337,000	4,075,814	01-Jan-25	45	1	45			45	48	4,860	1-Jan-76	40	4,820		W	S	Mcdanniel		
1041	B(39-05) 03BBD	GWSI	364850112492801	337,198	4,075,779	01-Jan-25	45	1				45	48	4,850	6-Aug-76	36	4,814		W	S	Bruce Mcdanniel		
1042	B(39-05) 03BCC	Wells 55	637319	337,097	4,075,478	16-Aug-33	40		40				48			32		8	PROD	S	Mcdaniel, Bruce,		
1043	B(39-05) 03BCC	Wells 55	637321	337,097	4,075,478	12-Jul-25	40		40				48			32		5	PROD	S	Mcdaniel, Bruce,		
1044	B(39-05) 03BDB	Wells 55	637320	337,505	4,075,672	26-Jun-27	40		40				48			32		10	PROD	S	Mcdaniel, Bruce,		
1045	B(39-05) 04AA	Wells 55	644763	336,800	4,075,985	01-Jan-46	60		60				10			40		10	PROD	S	Heaton,F E		
1045	B(39-05) 04AAC	GWSI	364854112495001	336,655	4,075,913		60	1				60	10	4,880	7-Aug-76	37	4,843		W	S	Fred Heaton		
1046	B(39-05) 05BAA	GWSI	364858112511601	334,526	4,076,077	01-Jan-33	57					57	48	5,000	12-Jan-65	56	4,944	0.5	W	S	Grant Heaton		
1046	B(39-05) 05BAA	Wells 35	14002	334,485	4,076,131	01-Jan-33	58		10				24			57		1	S	PROD	Heaton		
1046	B(39-05) 05BAA	Wells 55	624436	334,485	4,076,132	01-Mar-75	58		10				24			55			PROD	S	Heaton, Alan & Rosa,		
1047	B(39-05) 05DDB	Wells 55	614914	335,070	4,074,917		65						36			65			PROD	S	ASLD		
1048	B(39-05) 06BCC	Wells 55	577316	332,286	4,075,566														PROD	S	Heaton	Y	
1049	B(39-05) 06CC	Wells 55	624438	332,372	4,074,864	31-Dec-62	150		26				6			125		3	PROD	S	Heaton, Alan & Rosa,		
1049	B(39-05) 06CC	Wells 35	14003	332,372	4,074,864	28-Dec-62	150		26				6			125		3	S	PROD	Heaton		
1050	B(39-05) 06CCA	GWSI	364817112523701	332,494	4,074,853	01-Dec-62	150		126			150	6	5,100	12-Jan-65	126	4,974	3	W	S	ASLD		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1050	B(39-05) 06CCA	Wells 35	14004	332,472	4,074,963	31-Dec-62	150		26				6			125		3	S	PROD	Heaton		
1050	B(39-05) 06CCA	Wells 55	614915	332,472	4,074,963	31-Dec-62	150		20				4			150		3	PROD	S	ASLD		
1051	B(39-05) 06CCB	Wells 35	14005	332,275	4,074,966	01-Dec-62	150		26				6			126		3	S	PROD	Heaton		
1052	B(39-05) 08ABB	GWSI	364807112511201	334,595	4,074,504	14-Mar-74	100		100			100	4.5	5,035	7-Aug-76	37	4,998		T	U	Exxon Corp	Y	
1053	B(39-05) 08CC	Wells 55	525269	333,925	4,073,230														ME	NONE	Energy Fuels Nuclear,	Y	
1054	B(39-05) 11BBB	Wells 55	646298	338,698	4,074,447		150		150				6			85		5	PROD	S	Paler Estate,M J		
1055	B(39-05) 11BBB	GWSI	364809112482801	338,661	4,074,488		150					150	5	4,795					W	S	Palmer		
1056	B(39-05) 13CAB	Wells 55	513600	340,675	4,071,999	31-Mar-87	1,202						5						ME	NONE	BLM-AZ Strip Dist,	Y	
1057	B(39-05) 18ACD	Wells 55	645438	333,212	4,072,337	06-Jun-74	100		10				6			32		3	PROD	S	Heaton,E S		
1057	B(39-05) 18DCB	GWSI	364634112521001	333,101	4,071,666		100					100		5,260					W	S	Gene Heaton		
1058	B(39-05) 23	Wells 55	509076	339,322	4,070,514	06-Oct-84													ME	NONE	Pathfinder Mines Crp,		
1059	B(39-05) 26CBB	GWSI	364503112482301	338,676	4,068,753		340					340	5	4,760		323	4,437		W	S	Fred Heaton		
1060	B(39-05) 36AD	Wells 55	644765	341,483	4,067,441	01-Jan-45	50		25				10			18		20	PROD	S	Heaton,F E		
1061	B(39-05) 36ADC	GWSI	364417112462901	341,477	4,067,283		50					50		4,685	11-Aug-76	23	4,663		W	S	ASLD		
1061	B(39-05) 36DAA	Wells 55	614916	341,574	4,067,138		50		50				8			39		5	PROD	S	ASLD		
1062	B(39-06) 01DCC	GWSI	364813112532101	331,401	4,074,751		160					160		5,154					W	S	Keith Iverson		
1062	B(39-06) 01DCC	Wells 55	807534	331,473	4,074,779	31-Dec-34	190		40				6			175		3	PROD	S	Iverson, Keith,K		
1063	B(39-06) 02AAD	GWSI	364850112540001	330,457	4,075,911	31-Dec-71	202		117	117	202	202	6	5,120	2-Jan-72	168	4,952		W	S	ASLD		
1063	B(39-06) 02ADA	Wells 35	14006	330,490	4,075,795	31-Dec-71	202		117				6			31		1	S	PROD	Heaton		
1064	B(39-06) 02ADA	Wells 35	14007	330,490	4,075,795	01-Jan-40	185		38				6			178		1	K	X	Heaton	Y	
1065	B(39-06) 02ADA	Wells 55	614917	330,490	4,075,796	31-Dec-71	202		117				6			200		3	PROD	S	ASLD		
1066	B(39-06) 02ADA	Wells 55	624435	330,490	4,075,796	23-Sep-52													PROD	S	Heaton, Alan & Rosa,	Y	
1067	B(39-06) 10CDD	GWSI	364720112553901	327,948	4,073,186		145					145		5,305					U	U	Thomas Jensen	Y	
1067	B(39-06) 10CDD	Wells 55	646383	328,019	4,073,235	01-Jan-31	220		50				8			175		10	PROD	D	Jensen,S S		
1068	B(39-06) 12	Wells 35	14008	331,355	4,073,879	01-Jan-30	114		20				8			100		30	S	PROD	Jensen		
1069	B(39-06) 12CAA	GWSI	364740112532901	331,183	4,073,738			2					6	5,195	7-Aug-76	101	5,094		W	S	Sherman Jensen		
1070	B(39-06) 12CAA	Wells 55	646384	331,252	4,073,780	01-Jan-30	150		50				8			130		10	PROD	D	Jensen,S S		
1071	B(39-06) 12CAA	GWSI	364742112532701	331,234	4,073,799								5	5,190					W	S	Sherman Jensen		
1072	B(39-06) 12DAA	Wells 55	646382	332,052	4,073,767	01-Jan-30	114		20				8			100		15	PROD	D	Jensen,S S		
1073	B(39-06) 12DAA	Wells 55	646385	332,052	4,073,767	01-Jan-36	120		100				8			100		20	PROD	D	Jensen,S S		
1074	B(39-06) 14BAC	Wells 55	642988	329,422	4,072,809	01-Jan-60	100		100				6			75		5	PROD	S	Esplin Cattle Co,		
1075	B(39-06) 14BC	GWSI	364657112544701	329,223	4,072,451	01-Aug-57	2,303					2,303	10.75	5,310					OG	U	Lyons Poteet	Y	G
1076	B(39-06) 14BCA	GWSI	364702112544801	329,201	4,072,606	01-Jan-59	150					150	10	5,305	1-Jan-59	60	5,245		W	S	ASLD		
1077	B(39-06) 14BCC	Wells 55	642987	329,011	4,072,416	01-Jan-60	150		150				8			110		5	PROD	S	Esplin Cattle Co,		
1078	B(39-06) 14BCD	Wells 55	614919	329,213	4,072,413	31-Dec-69	150		150				8			110		5	PROD	S	ASLD		
1079	B(39-06) 14CAC	Wells 55	614918	329,409	4,072,009	01-Jan-70	100		100				6			75		5	PROD	S	ASLD		
1079	B(39-06) 14CAC	GWSI	364644112544101	329,364	4,072,048		100	1				100	5	5,300					W	S	ASLD		
1080	B(39-06) 22AAA	Wells 55	642981	328,793	4,071,420	01-Jan-60	80		80				6			70		5	PROD	S	Esplin Cattle Co,		
1081	B(39-06) 28ABB	Wells 55	549455	326,551	4,069,858	04-May-96	250		22				8						PROD	S	Neilson, Craig,H		
1082	B(39-06) 28ACB	Wells 55	204343	326,543	4,069,450		250		12				8						PROD	D	Yellowstone Ridge		
1083	B(39-06) 33DCC	GWSI	364352112563301	326,479	4,066,803									5,360					W	S	Lee Esplin		
1084	B(39-07) 02B	GWSI	364841113005401	320,192	4,075,843	01-May-66	4,031	6	221			4,031	10.75	5,070					OG	U	Skelly	Y	I
1085	B(39-07) 20D	Wells 55	517680	315,624	4,070,619	18-Jun-87													ME	NONE	Uranerz USA Inc,	Y	
1086	B(39-08) 03	Wells 55	907544	309,001	4,075,961															ME	Tournigan USA Inc.		
1087	B(39-08) 04CB0	Wells 55	642998	306,786	4,075,810	01-Jan-60	30		30				6			25		5	PROD	S	Esplin Cattle Co,		
1088	B(39-08) 05AD	Wells 55	642997	306,393	4,076,211	01-Jan-60	30		30				6			20		10	PROD	S	Esplin Cattle Co,		
1088	B(39-08) 05ADB	GWSI	364843113101801	306,216	4,076,211		30	2				30	6	4,725	11-Aug-76	12	4,713		W	S	Esplin Cattle Co		
1089	B(39-08) 05DA	Wells 55	642996	306,385	4,075,819	01-Jan-34	25		25				48			20		10	PROD	S	Esplin Cattle Co,		
1089	B(39-08) 05DBA	GWSI	364837113101801	306,212	4,076,026		20	3				20	36	4,700					W	S	Lee Esplin		
1090	B(39-08) 08	Wells 55	510046	305,751	4,074,439														ME	NONE	Pathfinder Mines Crp,	Y	
1091	B(39-08) 08	Wells 55	520588	305,751	4,074,439	30-Mar-88													ME	NONE	Pathfinder Mines Crp,	Y	
1092	B(39-08) 08	Wells 55	525586	305,751	4,074,439	30-Aug-89	1,510						5						ME	NONE	Pathfinder Mines Crp,	Y	

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1093	B(39-08) 10	Wells 55	520596	308,965	4,074,366														ME	NONE	Pathfinder Mines Crp,	Y	
1094	B(39-08) 11AD	Wells 55	644281	311,168	4,074,522	01-Jul-32	16		16				36			14		20	PROD	S	Foremaster Etal,G		
1094	B(39-08) 11ADC	GWSI	364747113070101	311,060	4,074,376		16					16		4,805	11-Aug-76	13	4,792		W	S	Foremaster		
1095	B(39-08) 15CA	Wells 55	644282	308,718	4,072,563	01-Apr-67	60		40				6			30		6	PROD	S	Foremaster Etal,A		
1095	B(39-08) 15CAB	GWSI	364650113084001	308,567	4,072,674		60	2				60	6	4,750					W	S	Foremaster		
1096	B(39-08) 27	Wells 55	510047	308,839	4,069,550														ME	NONE	Pathfinder Mines Crp,	Y	
1097	B(39-08) 27	Wells 55	517466	308,839	4,069,550														ME	NONE	Pathfinder Mines Crp,	Y	
1098	B(39-08) 27	Wells 55	520752	308,839	4,069,550	30-Mar-88													ME	NONE	Pathfinder Mines Crp,		
1099	B(39-08) 27AA	Wells 55	642994	309,463	4,070,137	01-Jan-34	25		25				48			20		5	PROD	S	Heaton Cattlle Company		
	B(39-08) 27AAB	GWSI	364528113080901	309,279	4,070,129		25					25	36	4,790	11-Aug-76	19	4,771		W	S	Esplin Cattle Co		
1100	B(39-08) 29AA	GWSI	364528113101401	306,179	4,070,199		20					20		4,960	16-Aug-51	17	4,944		UND	UND	Lee Esplin		
1101	B(39-08) 31	Wells 55	907552	303,976	4,068,053															ME	Tourningan USA Inc.		
1102	B(39-10) 21DCB	GWSI	364541113221501	288,308	4,071,024		550							4,300					X	U		Y	
1103	B(39-5) BA	AOGC		337,933	4,074,377	01-Jun-81	1,600							4,826						DH	Copaquen Pipe		
1104	B(39-6) CB	AOGC		329,125	4,072,494	01-Aug-57	2,303							5,310						DH	Poteet & Lyons		
1105	B(39-6) DC	AOGC		329,412	4,066,989	01-Sep-58	1,820							5,260						DH	Lyons, Tony		
1106	B(39-7) AD	AOGC		320,743	4,075,506	01-May-66	4,031							5,118						DH	Skelly Oil		
1107	B(40-02) 27BA	Wells 55	521833	366,491	4,078,583	30-Aug-88	190						5						ME	NONE	Energy Fuels Nuclear,	Y	
1108	B(40-02) 31	Wells 55	508850	361,847	4,076,439														ME	NONE	Pathfinder Mines Crp,	Y	
1109	B(40-02) 33A	Wells 55	521579	365,449	4,076,784	24-Aug-88	180						5						ME	NONE	Energy Fuels Nuclear,	Y	
1110	B(40-04) 04BBC	GWSI	365408112441201	345,206	4,085,433	09-Feb-71	128	1	121	121	128	128	6	4,970					T	U	NPS	Y	
1111	B(40-04) 05ACC	GWSI	365347112444301	344,427	4,084,800	01-Nov-69	99		84	84	94	99	8	5,020	28-Apr-70	69	4,951	27	W	MUN	PHS		
1112	B(40-04) 05BDA	GWSI	365400112444801	344,311	4,085,203	08-Feb-71	60		55	55	60	60	6	5,025					T	U	NPS	Y	
1113	B(40-04) 05CAD	GWSI	365339112445201	344,200	4,084,558		238					238		5,060					X	U	PHS	Y	
1114	B(40-04) 05CDD	GWSI	365325112445201	344,192	4,084,126	01-Mar-71	205		175	175	205	205	8	5,080	25-Mar-71	57	5,023	150	W	MUN	NPS		
1114	B(40-04) 05CDD	GWSI	365325112445201	344,192	4,084,126	01-Mar-71	205		205	175	205	205	6	5,080	25-Mar-71	57	5,023	150	W	MUN	NPS		
1114	B(40-04) 05CDD	Wells 35	14019	344,260	4,084,176	01-Jan-71	205		175				6			57		150	D	PROD			
1114	B(40-04) 05CDD	Wells 55	611159	344,260	4,084,176	24-Feb-73	205		175				8			57		150	PROD	D	Pipe Spring National Monument		
1115	B(40-04) 06AAC	GWSI	365403112452801	343,385	4,085,337	17-Jul-75	202	2	202	102	202	202	8.62	5,140	25-Oct-07	87	5,053	236	U	U	Kaibab-Pai	Y	
1116	B(40-04) 08BAB	GWSI	365324112445501	344,117	4,084,097	30-May-75	155	4	54	92	142	155	8	5,080	29-May-75	75	5,005	40.2	W	MUN	PHS		
116	B(40-04) 08BAB	GWSI	365324112445501	344,117	4,084,097	30-May-75	155	48	155	92	142	155	6	5,080	29-May-75	75	5,005	40.2	W	MUN	PHS		
1117	B(40-04) 10ACA	GWSI	365310112422501	347,823	4,083,598	28-Jan-71	100		87	87	100	100	6	4,820	28-Jan-71	65	4,755		X	U	NPS	Y	
1118	B(40-04) 14BCD	GWSI	365209112415101	348,631	4,081,703	27-Jan-71	46					46		4,680	27-Jan-71	35	4,645		X	U	NPS	Y	
1119	B(40-04) 17AAC	Wells 55	526126	344,827	4,082,156	02-Nov-89	200		200				4			105			PZ	T	Pipe Spring National Monument		
1120	B(40-04) 17DDB	GWSI	365149112442201	344,867	4,081,102									4,960					W	S	NPS		
1121	B(40-04) 17DDB	Wells 55	547325	344,811	4,081,154														MON	MON	Pipe Spring National Monument		
1122	B(40-04) 17DDB	Wells 55	547326	344,811	4,081,154														MON	MON	NPS		
1123	B(40-04) 17DDB	Wells 55	547327	344,811	4,081,154														MON	MON	NPS		
1124	B(40-04) 17DDB	Wells 55	547328	344,811	4,081,154														MON	MON	NPS		
1125	B(40-04) 17DDB	Wells 55	547329	344,811	4,081,154														PROD	MON	NPS		
1126	B(40-04) 19BA	Wells 55	644449	342,521	4,080,704		600						6					5	PROD	S	Bryant,J R		
1127	B(40-04) 19BBB	Wells 35	14020	342,034	4,080,814	01-Jan-61	650									200		12	S	PROD	Sanders		
1128	B(40-04) 31AAC	Wells 55	211708	343,162	4,077,382	20-Aug-06	360		260				6			43			PROD	S	Heaton		
1129	B(40-04) 31DAA	Wells 55	592335	343,349	4,076,772		260		260				6						PROD	S	Heaton		
1130	B(40-04) 31DDD	Wells 55	910822	343,339	4,076,166																		
1131	B(40-04)10ACB	GWSI	365310112422801	347,748	4,083,600	01-Feb-71	100		66	66	100	100	6	4,810	1-Feb-71	90	4,720		X	U	NPS	Y	
1132	B(40-05) 17A	Wells 55	641939	335,111	4,082,250	30-Apr-80	100		100				6			60		2	PROD	S	Reeve,A		
1133	B(40-05) 17AAD	Wells 55	614924	335,418	4,082,342								5			30			PROD	S	ASLD		
1134	B(40-05) 19CDD	Wells 55	649827	332,958	4,079,575	01-Jan-20										150		5	PROD	S	Langston,V		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1134	B(40-05) 19DCC	GWSI	365050112521201	333,206	4,079,556								6	4,900					W	S	Verel Langston		
1135	B(40-05) 19DDC	Wells 55	647391	333,548	4,079,565		150		150				8			120		35	PROD	S	Langston,V		
1136	B(40-05) 20C	Wells 55	641944	334,251	4,079,858		125		125				6			80		4	PROD	S	Reeve,A		
1137	B(40-05) 20CCC	GWSI	365049112514501	333,874	4,079,512		125					125		4,891					W	S	Ashby Reeve		
1138	B(40-05) 21CCD	GWSI	365049112502601	335,831	4,079,474		400	1				400	8	4,875	6-Sep-76	67	4,808		W	S	Bowler		
1139	B(40-05) 30AB	Wells 55	644764	333,248	4,079,268	01-Jan-20	132		132				8			73		20	PROD	S	Heaton,F E		
1140	B(40-05) 30ABB	GWSI	365045112521001	333,253	4,079,401		132	1				132	8	4,900					W	S	Fred Heaton		
1141	B(40-05) 30BAA	Wells 55	526281	332,954	4,079,373	16-Dec-89	190		80				6			66		5	PROD	REC	Iverson, Keith,		
1142	B(40-05) 31ACD	Wells 55	580536	333,308	4,077,160	19-Apr-00	177		177				5			135			PROD	S	Heaton		
1143	B(40-05) 35BCD	Wells 55	527558	338,944	4,077,059	28-Mar-90	70												PROD	S	Heaton, I Mckay,		
1144	B(40-05) 35CCC	Wells 55	591999	338,731	4,076,256		120		120				6			81			PROD	S	Heaton		
1145	B(40-05) 36DDB	Wells 35	14021	341,565	4,076,403	20-Jul-80	200		75				7			30		10	S	PROD	Iverson		
1146	B(40-05) 36DDB	Wells 55	603408	341,565	4,076,404	01-Jan-80	200		78				6			30		5	PROD	S	Iverson,K K		
1147	B(40-05) 36DDB	Wells 55	614925	341,565	4,076,404	01-Jan-80	200		80				6			45		7	PROD	S	ASLD	Y	
1148	B(40-06) 01DDA	Wells 55	205571	332,260	4,084,602														PROD	D	Shelley		
1149	B(40-06) 02AAA	Wells 55	507211	330,678	4,085,743														X	NONE	Pathfinder Mines Crp,	Y	
1150	B(40-06) 02BAA	Wells 55	515448	329,876	4,085,756														PROD	D	Lovell, Dwayne,B	Y	
1151	B(40-06) 03CAC	Wells 55	515691	328,042	4,084,863	15-Oct-86	305		251				8			22		3	PROD	S	Hinton, Harold,		
1152	B(40-06) 04BAA	Wells 55	552273	326,646	4,085,820														MON	MON	Colorado City, Town,		
1153	B(40-06) 05BCC	Wells 55	552272	324,435	4,085,307														MON	MON	Colorado City, Town,		
1154	B(40-06) 07BCB	Wells 55	214723	322,818	4,083,997														PROD	D	Shelley		
1155	B(40-06) 12	Wells 55	514227	331,536	4,083,527														ME	NONE	Pathfinder Mines Crp,	Y	
1156	B(40-06) 12CCB	GWSI	365241112534901	330,871	4,083,024	01-Jun-57	2,202	7				2,202	6	5,240					X	U	Word T George-	Y	G
1157	B(40-06) 13	Wells 55	507209	331,503	4,081,918	03-May-86													X	NONE	Pathfinder Mines Crp,	Y	
1158	B(40-06) 13	Wells 55	514228	331,503	4,081,918														ME	NONE	Pathfinder Mines Crp,	Y	
1159	B(40-06) 13ABC	Wells 55	537616	331,613	4,082,416	18-Dec-92	224		224				9			181			MON	MON	Pathfinder Mines Crp,		
1160	B(40-06) 13ABC	Wells 55	537617	331,613	4,082,416	24-Dec-92	225		225				9			180			MON	MON	Pathfinder Mines Crp,		
1161	B(40-06) 13ABC	Wells 55	537618	331,613	4,082,416	28-Dec-92	225		225				6			178			MON	MON	Pathfinder Mines Crp,		
1162	B(40-06) 17BCC	Wells 55	640566	324,369	4,082,159	01-Apr-61	165		145				6			130		5	PROD	S	Foremaster, Howard,		
1162	B(40-06) 18ADD	GWSI	365205112582001	324,138	4,082,051		145					145	6	5,020					W	S	Foremaster		
1163	B(40-06) 21AAA	Wells 55	642370	327,367	4,081,089	01-Apr-78	300						8			250		50	PROD	S	Hinton,A		
1163	B(40-06) 21AAA	GWSI	365138112560801	327,390	4,081,152		265					265		5,060	6-Aug-76	186	4,875		W	S	A Hinton		
1164	B(40-06) 23CCC	GWSI	365050112545501	329,168	4,079,636		257					257	6	5,070	6-Aug-76	209	4,861		W	S	Dica Langston		
1164	B(40-06) 23CCC	Wells 55	642026	329,159	4,079,645	01-Jan-40	180											10	PROD	S	Langston, Lamond,C		
1165	B(40-06) 23DAA	Wells 55	642025	330,570	4,080,224		100						6					10	PROD	S	Langston, Lamond,C		
1166	B(40-06) 23DAB	Wells 35	14022	330,370	4,080,228	01-Jan-44	300		260				6						S	PROD	Langston		
1167	B(40-06) 23DCA	GWSI	365059112541101	330,264	4,079,892	01-Jan-74		2					6	5,080					W	S	Perkins		
1168	B(40-06) 24DDC	Wells 55	649828	331,967	4,079,593	01-Jan-43										175		5	PROD	S	Langston,V		
1169	B(40-06) 26	Wells 35	14023	329,840	4,078,727	01-Jan-28	240		20				8			240		3	S	PROD	Jenson		
1169	B(40-06) 26BBB	Wells 55	646381	329,155	4,079,444	01-Jan-28	240		20				8			240		21	PROD	D	Jensen,S S		
1169	B(40-06) 26BBB	GWSI	365044112545501	329,165	4,079,451		250					250	6	5,070					W	S	Sherman Jensen		
1170	B(40-06) 29AAB	GWSI	365043112572301	325,498	4,079,495		260					260	6	5,075	6-Aug-76	230	4,845		W	S	Dica Langston		
1171	B(40-06) 30	GWSI	365020112584501	323,452	4,078,828		296					296		5,080					UND	UND			
1172	B(40-06) 30AAA	Wells 35	14024	324,114	4,079,561	23-Nov-64	290		260	250	260		8			240		5	S	PROD	Iverson		
1172	B(40-06) 30AAA	GWSI	365046112582001	324,088	4,079,616		290		148	260	290	290	8	5,070	20-Nov-64	260	4,810	5	W	S	ASLD		
1172	B(40-06) 30AAA	GWSI	365046112582001	324,088	4,079,616		290		148	250	260	290	8	5,070	20-Nov-64	260	4,810	5	W	S	ASLD		
1172	B(40-06) 30AAA	GWSI	365046112582001	324,088	4,079,616		290	148	260	260	290	290	6	5,070	20-Nov-64	260	4,810	5	W	S	ASLD		
1172	B(40-06) 30AAA	GWSI	365046112582001	324,088	4,079,616		290	148	260	250	260	290	6	5,070	20-Nov-64	260	4,810	5	W	S	ASLD		
1173	B(40-06) 30AAB	Wells 55	603406	323,916	4,079,565	01-Jan-64	300		300				8			260		5	PROD	S	Iverson,K K		
1174	B(40-06) 30AAB	Wells 55	614926	323,916	4,079,565	31-Dec-64	300		300				4			240		5	PROD	S	ASLD		
1175	B(40-06) 31BA	Wells 55	641820	323,195	4,077,863	14-Feb-41	300		100				6			289		10	PROD	S	Brinkerhoff, William,		
1175	B(40-06) 31BAA	GWSI	364955112585201	323,263	4,078,061		451					451		5,120					W	S	Brinkerhof		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1176	B(40-06) 32AAA	Wells 55	603407	325,694	4,077,900	01-Jan-61	300		300				8			280		5	PROD	S	Iverson,K K		
1177	B(40-06) 32AAA	Wells 55	614927	325,694	4,077,900	31-Dec-60	300		300				4			300		4	PROD	S	ASLD		
1177	B(40-06) 32AAA	GWSI	364952112571401	325,689	4,077,918		300					300		5,110					W	S	ASLD		
1178	B(40-06) 33BBB	GWSI	364951112570601	325,886	4,077,883		300	1				300	8	5,110					W	S	Langston		
1178	B(40-06) 33BBB	Wells 55	648237	325,896	4,077,895		330		330				10			290		5	PROD	S	Langston,R J		
1179	B(40-07) 04CC	Wells 55	644284	316,502	4,084,833	15-Jul-53	600						8			150		2	PROD	S	Pearce,G		
1179	B(40-07) 04CCC	GWSI	365327113033501	316,392	4,084,743		600					600	8	4,970					W	S	G Pearce		
1180	B(40-07) 15	Wells 55	519087	318,668	4,082,185														ME	NONE	Uranerz, U.S.A. Inc.,	Y	
1181	B(40-07) 15	Wells 55	519207	318,668	4,082,185														ME	NONE	Uranerz USA Inc.,	Y	
1182	B(40-07) 16	GWSI	360205113030801	317,006	4,082,201		265					265		4,950					UND	UND	Lee Esplin		
1183	B(40-07) 20CA	Wells 55	642989	315,201	4,080,460	01-Jan-65	80		80				6			70		5	PROD	S	Esplin Cattle Co,		
1183	B(40-07) 20CAC	GWSI	365105113042501	315,059	4,080,393		30	1	30			30	42	4,920					W	S	Esplin Cattle Co		
1184	B(40-08) 03CD0	Wells 55	641942	308,917	4,085,007		20		20				4			15		2	PROD	S	Reeve,A		
1185	B(40-08) 14A	Wells 55	641943	311,070	4,082,748		80		80				6			60		4	PROD	S	Reeve,A		
1185	B(40-08) 14ABC	GWSI	365220113072201	310,727	4,082,801		80					80		4,845					W	S	A Reeve		
1186	B(40-08) 17DC	Wells 55	642995	306,041	4,081,855	01-Jan-34	21		21				48			16		15	PROD	S	Esplin Cattle Co,		
1186	B(40-08) 17DCB	GWSI	365150113103201	306,001	4,081,983		16	1				16	36	4,700	13-Jun-51	14	4,687		W	S	Lee Esplin		
1187	B(40-08) 28CDA	GWSI	365001113093801	307,262	4,078,593	01-Aug-56	3,753	4				3,753	6.5	4,710					OG	U	Seaboard Falcon	Y	GM
1188	B(40-08) 29CCC	GWSI	365003113110701	305,058	4,078,705	29-Jun-73	50		40	14	40	50	6	4,690	29-Jun-73	21	4,670	6	W	S	Ashby Reeve		
1188	B(40-08) 29CCC	Wells 35	14025	305,481	4,078,947	29-Jun-73	50		40	14	40		6			21		6	S	PROD	Reeve		
1189	B(40-08) 30CA	Wells 55	641819	304,037	4,079,082	22-Dec-50	335		70				6			250		10	PROD	S	Brinkerhoff,W B		
1190	B(40-08) 31A	Wells 55	517670	304,582	4,078,059	11-May-87	295						5						ME	NONE	Uranerz USA Inc,	Y	
1191	B(40-09) 22	Wells 55	510044	299,478	4,081,002	01-Jun-85	1,360		20				6			2,350			X	NONE	Pathfinder Mines Crp,	Y	
1192	B(40-6) AA	AOGC		328,760	4,079,308	01-Nov-83	2,500							5,070						DH	Brooks Exploration		
1193	B(40-6) BB	AOGC		329,247	4,079,321	01-Jun-85	595							5,070						DH	Waggoner, W.M.		
1194	B(40-6) BB	AOGC		329,245	4,079,350	01-Feb-83	7,070							5,085						DH	Brooks Exploration		
1195	B(40-6) BC	AOGC		330,930	4,083,329	01-Jun-57	2,202							5,250						DH	George, T.W.		
1196	B(40-8) DC	AOGC		307,146	4,078,586	01-Jun-56	120							4,808						DH	Valen Oil & Gas		
1197	B(40-8) DC	AOGC		307,147	4,078,604	01-Aug-56	3,753							4,718						DH	Falcon Seaboard		
1198	B(40-9) AC	AOGC		294,295	4,082,430	01-Nov-77	4,509							4,958						DH	Pyramid Oil		
1199	B(41-01) 03DDA	Wells 55	512750	377,259	4,093,406	15-Jan-86	101		101				4			30		15	PROD	S	Pugh, Roger,M		
1200	B(41-01) 11CCC	Wells 55	562853	377,436	4,091,587	15-Oct-97	82		82				5			35		4	PROD	S	Heaton		
1201	B(41-01) 14BCA	GWSI	365725112222301	377,692	4,090,976	15-Feb-76	150		50	50	150	150	12.75	4,900					U	U	R Thomas	Y	
1202	B(41-01) 14BCA	Wells 35	14042	377,630	4,090,979	15-Feb-71	150		50				13						S	PROD	Thomas		
1203	B(41-01) 15AB	Wells 55	641011	376,729	4,091,295		300		20				8			35		3	PROD	D	Grand Cnyn Scenic,		
1204	B(41-01) 15CAB	Wells 35	14043	376,217	4,090,596	01-Jan-71	360		30				12			27				WD			
1205	B(41-01) 15CBA	GWSI	365713112233401	375,931	4,090,632	25-Aug-71	360		30	30	360	360	12	4,885	9-Aug-76	27	4,858		W	S	G Thomas		
1206	B(41-01) 15DDB	Wells 35	14044	377,020	4,090,179	25-Aug-71	360		30				12			27		3	I	PROD	Thomas		
1207	B(41-01) 33CC	Wells 55	641012	374,234	4,085,297		300		20				8			35		3	PROD	S	Grand Cnyn Scenic,		
1208	B(41-02) 05ABC	GWSI	365913112314501	363,846	4,094,516		770					770		4,800					U	U	Milt Cram	Y	
1209	B(41-02) 05ADC	Wells 55	555888	364,197	4,094,189														PROD	I	Agassiz, Louis Trust,	Y	
1210	B(41-02) 05BAB	GWSI	365920112320001	363,478	4,094,738	01-Jan-56	400					400	12.62	4,800					U	U	Milt Cram	Y	
1211	B(41-02) 06BCC	Wells 35	14045	361,389	4,094,226	18-Aug-79	260		162				6						S	PROD	Mace		
1211	B(41-02) 06BCC	Wells 55	603672	361,389	4,094,226	01-Aug-64	260		162				8			50		200	PROD	I	Mace,R G		
1212	B(41-02) 06CBA	Wells 55	585984	361,586	4,094,022														PROD	I	Town of Fredonia	Y	
1213	B(41-02) 06CBB	GWSI	365856112332401	361,389	4,094,032	25-Oct-63	220		65	65	220	220	8	4,805	25-Apr-73	47	4,758	150	U	U	Ronald Mace	Y	
1214	B(41-02) 06CCB	Wells 35	14046	361,383	4,093,623	25-Oct-63	220		57				8			46			UTIL	PROD	Fredonia Wtr Conser		
1215	B(41-02) 07BBD	Wells 55	541013	361,575	4,093,016	08-Jan-94	1,400		1,400				8			650			PROD	M	Fredonia, City of,		
1216	B(41-02) 08AAD	Wells 55	580013	364,382	4,092,977	22-Apr-00	45		45				2						MON	T	Crown Asphalt Products Company		
1217	B(41-02) 08ABC	Wells 55	532251	363,774	4,092,985	24-Jul-91	27		16				4			16			MON	MON	Petro Source Corp,		
1218	B(41-02) 08ABC	Wells 55	532252	363,774	4,092,985	23-Jul-91	26		16				4			16			MON	MON	Petro Source Corp,		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1219	B(41-02) 08ABC	Wells 55	532253	363,774	4,092,985														MON	MON	Petro Source Corp,	Y	
1220	B(41-02) 08ABC	Wells 55	532254	363,774	4,092,985														MON	MON	Petro Source Corp,	Y	
1221	B(41-02) 08ABC	Wells 55	543451	363,774	4,092,985														MON	MON	Petro Source Refing,	Y	
1222	B(41-02) 08ABC	Wells 55	543452	363,774	4,092,985														MON	MON	Petro Source Refing,	Y	
1223	B(41-02) 08ABC	Wells 55	543453	363,774	4,092,985														MON	MON	Petro Source Refing,	Y	
1224	B(41-02) 08ABC	Wells 55	543454	363,774	4,092,985														MON	MON	Petro Source Refing,	Y	
1225	B(41-02) 08ABC	Wells 55	543455	363,774	4,092,985														MON	MON	Petro Source Refing,	Y	
1226	B(41-02) 08ABC	Wells 55	543456	363,774	4,092,985														MON	MON	Petro Source Refing,	Y	
1227	B(41-02) 09CBB	Wells 55	609894	364,575	4,092,374	25-May-72	870		723				8			420		400	PROD	I	Judd,L P		
1228	B(41-02) 09CCA	Wells 35	14047	364,771	4,091,971	01-May-72	895		725				8			800			I	PROD	Judd		
1229	B(41-02) 09CDB	GWSI	365752112310001	364,918	4,092,002	01-May-72	895	1	725	725	895	895	8.62	4,750	10-Aug-76	426	4,324	50	U	U	Leroy Judd	Y	D
1230	B(41-02) 13DD	Wells 55	511226	370,679	4,090,183														ME	NONE	Energy Fuels Nuclear,	Y	
1231	B(41-02) 13DD	Wells 55	523979	370,679	4,090,183														ME	NONE	Energy Fuels Nuclear,	Y	
1232	B(41-02) 16ABA	Wells 55	585624	365,567	4,091,560	07-Mar-01	900		790				10			820		150	PROD	D	Town of Fredonia		
1233	B(41-02) 19AAA	Wells 55	909010	362,718	4,089,993																Karr		
1234	B(41-02) 20	Wells 55	643761	363,620	4,089,277	01-Jan-50	95		95				8								Goodall, Eva,M		
1235	B(41-02) 20ABA	Wells 55	532368	363,933	4,089,977	10-Jul-91	14		10				2			12			MON	MON	USDAG	Y	
1236	B(41-02) 20ABA	Wells 55	532369	363,933	4,089,977	10-Jul-91	14		14				2			12			MON	MON	Kaibab Nat Forest	Y	
1237	B(41-02) 20ABA	Wells 55	540990	363,933	4,089,977	03-Nov-93	20		8				4			12			MON	MON	Us Forest Service,	Y	
1238	B(41-02) 20ABA	Wells 55	540991	363,933	4,089,977	04-Nov-93	20		8				4			12			MON	MON	Us Forest Service,	Y	
1239	B(41-02) 20ABA	Wells 55	540992	363,933	4,089,977		20		8				4			12			G	NONE	Kaibab Natl Forest,	Y	
1240	B(41-02) 20ABA	Wells 55	540993	363,933	4,089,977														MON	MON	Us Forest Service,	Y	
1241	B(41-02) 20ABA	Wells 55	542897	363,933	4,089,977	19-Aug-94	20		7				4			15			MON	MON	Us Forest Service,	Y	
1242	B(41-02) 20ABA	Wells 55	542898	363,933	4,089,977	19-Aug-94	20		7				4			15			MON	MON	Us Forest Service,	Y	
1243	B(41-02) 20ABA	Wells 55	542899	363,933	4,089,977	19-Aug-94	20		7				4			15			MON	MON	Us Forest Service,	Y	
1244	B(41-02) 21BCC	Wells 55	578524	364,533	4,089,365	20-Feb-00	34		34				2			33			MON	MON	Judd Auto Service		
1245	B(41-02) 21BCC	Wells 55	578525	364,533	4,089,365	05-Jun-07	36		36				4			31			MON	MON	Judd Auto Service		
1246	B(41-02) 21BCC	Wells 55	578526	364,533	4,089,365	20-Feb-00	34		34				4			29			MON	MON	Judd Auto Service		
1247	B(41-02) 21BCC	Wells 55	578527	364,533	4,089,365	20-Feb-00	34		34				4			29			MON	MON	Judd Auto Service		
1248	B(41-02) 21BCC	Wells 55	578528	364,533	4,089,365	20-Feb-00	40		40				4			35			MON	MON	Judd Auto Service		
1249	B(41-02) 21BCC	Wells 55	578529	364,533	4,089,365	20-Feb-00	40		40				4			35			MON	MON	Judd Auto Service		
1250	B(41-02) 21BCC	Wells 55	578530	364,533	4,089,365	20-Feb-00	34		34				4			28			MON	MON	Judd Auto Service		
1251	B(41-02) 21BCC	Wells 55	578531	364,533	4,089,365														MON	MON	Judd Auto Service	Y	
1252	B(41-02) 21BCC	Wells 55	585328	364,533	4,089,365	21-Feb-01	25		25				2			12			MON	T	Judd Auto Service		
1253	B(41-02) 21BCC	Wells 55	598251	364,533	4,089,365		25		25				2			12			MON	MON	Judd Auto Service		
1254	B(41-02) 21BCC	Wells 55	598252	364,533	4,089,365		25		25				2			12			MON	MON	Judd Auto Service		
1255	B(41-02) 21BCC	Wells 55	598253	364,533	4,089,365		25		25				2			12			MON	MON	Judd Auto Service		
1256	B(41-02) 21BCC	Wells 55	598254	364,533	4,089,365		25		25				2			12			MON	MON	Judd Auto Service		
1257	B(41-02) 21CCC	Wells 55	585327	364,522	4,088,560	20-Feb-01	33		331				4			12			MON	T	Judd Auto Service		
1258	B(41-02) 21CCC	Wells 55	585329	364,522	4,088,560	20-Feb-01	33		33				4			12			MON	T	Judd Auto Service		
1259	B(41-02) 25DDD	GWSI	365508112270001	370,777	4,086,856	01-Dec-61	940		80	80	210	210	6.62	4,760	10-Aug-76	181	4,579		U	U	Harold Pratt	Y	D
1260	B(41-02) 25DDD	Wells 35	14048	370,739	4,086,861		210		80				6			128		2	STOCK	PROD			
1261	B(41-02) 30DAA	Wells 55	527689	362,691	4,087,580														PROD	I	Griffiths, C.A. Jr,	Y	
1262	B(41-02) 35CAD	GWSI	365427112283901	368,308	4,085,630	31-Jul-71	650		81	81	650	650	8.87	4,720	10-Aug-76	407	4,313	1.5	U	U	A Jensen	Y	D
1263	B(41-02) 35CDA	Wells 35	14049	368,290	4,085,484	03-Jul-71	650		81				8			118		2	S	PROD	Jensen		
1264	B(41-04) 28ADA	Wells 55	644450	346,595	4,088,265		1,100						6					5	PROD	S	Bryant,J R		
1265	B(41-04) 31AAC	Wells 35	14051	343,201	4,086,891	10-Feb-72	70		15				8			11		60	I	PROD	Red Rock Ranch		
1265	B(41-04) 31AAC	Wells 55	621238	343,201	4,086,891	28-Feb-72	150		40				4			40		50	PROD	I	Heaton,I M		
1266	B(41-04) 31ABD	GWSI	365452112453901	343,078	4,086,829									5,120					W	S	Landell Heaton		
1267	B(41-04) 31ABD	GWSI	365452112454201	343,004	4,086,830	20-Mar-72	110		14	14	110	110	10	5,200	20-Mar-72	75	5,125	175	U	U	Landell Heaton	Y	
1268	B(41-04) 31ACA	GWSI	365446112464001	341,565	4,086,672	10-Feb-72	70		15	15	70	70	8	5,170	10-Feb-72	11	5,160	100	W	D	Mckay		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1269	B(41-04) 31ACD	GWSI	365440112454101	343,022	4,086,460	01-Mar-68	80		70	70	80	80	6	5,140	17-Jan-69	37	5,103	25	W	D	Moccasin Domestic		
1269	B(41-04) 31ACD	Wells 35	14052	342,993	4,086,494	01-Jan-68	80		70				6			37		25	D	PROD			
1270	B(41-04) 31ADB	Wells 55	621237	343,198	4,086,691	20-Jun-73	200		30				3			60		60	PROD	I	Heaton,I M		
1271	B(41-04) 31ADB	Wells 55	648424	343,198	4,086,691	01-Apr-72	100						10			80		20	PROD	D	Heaton,D		
1271	B(41-04) 31ADB	Wells 35	14053	343,198	4,086,691	20-Mar-72	110		14				11			75		175	I	PROD	Heaton		
1272	B(41-04) 31ADC	GWSI	365438112453501	343,169	4,086,396									5,120					W	I	Owen Johnson		
1273	B(41-04) 31ADC	Wells 55	650645	343,195	4,086,491	01-Jan-67	80		80				6			43		20	PROD	D	Moccasin Domestic,		
1274	B(41-04) 31ADD	Wells 55	905496	343,398	4,086,488															D	Rollins		
1275	B(41-04) 31BCA	Wells 55	527559	342,187	4,086,707	06-Apr-90	140		22				8			51			PROD	I	Heaton, I Mckay,		
1276	B(41-04) 31BCB	Wells 55	528195	341,984	4,086,710	16-Jun-90	160		16				8			50		420	PROD	I	Heaton, I Mckay,		
1277	B(41-04) 31CAA	Wells 55	526741	342,586	4,086,301	06-Jun-90	150		150				8			33		85	PROD	M	Rogers, Royce W Etal,		
1278	B(41-04) 31CAB	GWSI	365435112460301	342,474	4,086,316									5,160					W	MUN	Moc Wt As		
1279	B(41-04) 31DAA	Wells 35	14054	343,395	4,086,288	01-Jan-72	80		67				11			19			I	PROD	Schmutz		
1280	B(41-04) 31DAB	Wells 35	14055	343,193	4,086,291	19-Jan-72	80		67	35	65		11			19		550	I	PROD	Schmutz		
1280	B(41-04) 31DAB	GWSI	365435112453701	343,118	4,086,304	19-Jan-72	80		67	35	65	80	10.75	5,120	19-Jan-72	19	5,101		W	D	William Schmutz		
1281	B(41-04) 31DAC	Wells 55	624434	343,190	4,086,091	01-Mar-72	95		25				8			23		600	PROD	I	Heaton,J G		
1281	B(41-04) 31DAC	Wells 35	14056	343,190	4,086,091	21-Mar-72	95		30				8			77			I	PROD	Heaton		
1282	B(41-04) 31DAD	Wells 55	556288	343,392	4,086,088	20-Dec-96	108		108				8			22			PROD	D	Iverson, Keith,		
1283	B(41-04) 31DBA	GWSI	365433112454501	342,919	4,086,246	01-Mar-67	120		120			120	6	5,110	15-Apr-68	4	5,106		U	U	J Heaton	Y	
1283	B(41-04) 31DBA	Wells 35	14057	342,990	4,086,294	01-Jan-67	120		120				6			3			K	X		Y	
1283	B(41-04) 31DBA	Wells 55	651144	342,990	4,086,295	01-Jan-66	123		123				8			4					Heaton,J G		
1283	B(41-04) 31DBA	GWSI	365436112454501	342,920	4,086,339									5,130					W	I	Moc Wt As		
1284	B(41-04) 31DBD	Wells 35	14058	342,988	4,086,095	01-Jan-72	95		30				8			18				WD			
1285	B(41-04) 31DDA	Wells 55	518690	343,389	4,085,888	15-Nov-87	295		208				8			175		150	PROD	I	Johnson, David,O		
1286	B(41-04) 31DDB	GWSI	365424112453401	343,186	4,085,964	21-Mar-72	95		30	30	95	95	8	5,120	21-Mar-72	18	5,102		W	D	J Heaton		
1287	B(41-04) 31DDD	GWSI	365412112452401	343,426	4,085,589		65					65		5,160		36	5,124		W	D			
1288	B(41-04) 32CB	Wells 55	649200	343,692	4,086,182	14-Jul-78	130		100				8			60		25	PROD	D	Tracy,B G		
1289	B(41-04) 32CBB	Wells 35	14059	343,595	4,086,284	01-Jan-68	120												K	X		Y	
1290	B(41-04) 32CBB	Wells 35	14060	343,595	4,086,284		186												I	PROD	Johnson		
1291	B(41-04) 32CBB	GWSI	365436112451801	343,588	4,086,326		120					120		5,050					X	U	Owen Johnson	Y	
1292	B(41-04) 32CBD	Wells 35	14061	343,789	4,086,080	05-Jul-28	140		100				8			12		50	I	PROD	Tracy		
1293	B(41-04) 32CCC	Wells 55	621499	343,586	4,085,684	26-Jan-72	70						7			40		175	PROD	I	Heaton,M C		
1293	B(41-04) 32CCC	Wells 35	14062	343,586	4,085,684	26-Jan-72	70		8				7			40		200	I	PROD	Heaton		
1294	B(41-05) 32	Wells 55	581023	334,616	4,086,564																Wharton		
1295	B(41-06) 16DDD	GWSI	365650112561501	327,412	4,090,771		635					635	9	5,025					U	U		Y	
1295	B(41-06) 16DDD	GWSI	365650112561501	327,412	4,090,771		635					635	8	5,025					U	U		Y	
1296	B(41-06) 28DBC	Wells 55	628979	326,697	4,088,024	01-Feb-68	540		500				8			100			PROD	I	O'brien,Z C		
1297	B(41-06) 31CDD	Wells 55	523093	323,230	4,086,089	21-Feb-89	590		500				12			230		400	PROD	M	Twin City Water Work,		
1298	B(41-06) 35CCB	Wells 55	562599	329,076	4,086,165														PROD	I	Finicum, David,R		
1299	B(41-06) 36DDC	Wells 55	507210	331,904	4,085,917														X	NONE	Pathfinder Mines Crp,	Y	
1300	B(41-07) 01BCC	Wells 55	513374	321,189	4,094,985	27-Mar-86	700		670				8			400			PROD	I	United Effort Plan,		
1301	B(41-08) 18BAA	GWSI	365739113115701	304,144	4,092,787	01-Jan-32	1,522	1	80			1,522	8	4,510					OG	U	Petroleum Antelope	Y	D
1301	B(41-08) 18BAA	Wells 35	14097	304,078	4,092,788		1,522		80				8			600			S	PROD			
1302	B(41-09) 03	Wells 55	525585	299,401	4,095,410	30-Aug-89	1,210						5						ME	NONE	Pathfinder Mines Crp,	Y	
1303	B(41-09) 03A	Wells 55	522169	299,808	4,095,800	29-Aug-88	1,860						6						ME	NONE	Uranerz, U.S.A. Inc,	Y	
1304	B(41-09) 09	Wells 55	517467	297,756	4,093,848	24-Nov-87	1,098						3						ME	NONE	Pathfinder Mines Crp,	Y	
1305	B(41-09) 11	Wells 55	510050	300,974	4,093,759	07-Mar-86	1,900												X	NONE	Pathfinder Mines Crp,	Y	
1306	B(41-1) AB	AOGC		379,622	4,089,715	01-Jan-83	540							4,966						DH	Shields Explr. Co.		
1307	B(41-1) AC	AOGC		379,611	4,088,730	01-May-85	750							5,043						DH	Shields Explr. Co.		
1308	B(41-1) AC	AOGC		379,603	4,088,958	01-May-85	480							5,037						DH	Shields Explr. Co.		
1309	B(41-1) BD	AOGC		379,806	4,088,713	01-May-85	500							5,072						DH	Shields Explr. Co.		

Table D-1. Summary of Records for Selected Wells (Continued)

Project Site No.	Cadastral Location	Record Source	Database Identifier	UTM NAD 83 Coordinates Easting (meters)	UTM NAD 83 Coordinates Northing (meters)	Completion Date	Hole Depth (ft, bls)	Depth to Top of Casing (ft, bls)	Depth to Bottom of Casing (ft, bls)	Top of Perforations (ft, bls)	Bottom of Perforations (ft, bls)	Well Depth (ft, bls)	Casing Diameter (inches)	Well Altitude (ft, msl)	Water Level Measurement Date	Depth to Water (ft, bls)	Water Level Altitude (ft, msl)	Pump Capacity (gpm)	Site Use	Water Use	Owner	Well Cancel	Log Type
1310	B(41-1) BD	AOGC		379,927	4,088,801	01-Jun-80	900							5,068						DH	Travis Oil		
1311	B(41-1) BD	AOGC		379,932	4,088,853	01-Dec-81	482							5,062						DH	Shields Explr. Co.		
1312	B(41-1) BD	AOGC		378,185	4,088,860	01-Jan-83	550							4,983						DH	Shields Explr. Co.		
1313	B(41-1) BD	AOGC		380,019	4,088,907	01-Jan-83	491							5,066						STRAT	Shields Explr. Co.		
1314	B(41-1) DA	AOGC		380,332	4,089,218	01-Mar-95	5,436							5,026						DH	Shields Explr. Co.		
1315	B(41-10) 20	Wells 55	520905	286,409	4,090,912		2,000						6						ME	NONE	Uranerz, U.S.A. Inc.,	Y	
1316	B(41-10) 29B	Wells 55	517663	285,976	4,089,715	31-Dec-87	1,608		6										ME	NONE	Uranerz USA Inc,	Y	
1317	B(41-11) AD	AOGC		280,682	4,094,121	01-Feb-96	1,100							3,090						JA	Premco Western		
1318	B(41-6) D	AOGC		327,278	4,090,925	01-Jan-31	542							5,030						DH	Cane Bed		
1319	B(41-8) AB	AOGC		304,103	4,092,775	01-Jan-32	1,522							4,515						DH	Antelop Petroleum		
1320	B(41-9) BB	AOGC		297,111	4,087,939	01-Apr-81	3,530							5,009						DH	Pyramid Oil		
1321	B(41-9) BD	AOGC		297,894	4,088,625	01-Dec-77	4,150							4,763						DH	Pyramid Oil		
1322	B(42-02) 32ACA	Wells 55	508806	364,012	4,095,630														PROD	D	Cliff,V	Y	
1323	B(42-02) 32ACA	Wells 55	801628	364,012	4,095,630	01-May-74	150		55				6			10			PROD	S	Cliff,V		
1323	B(42-02) 32ACA	Wells 35	14132	364,012	4,095,630	05-Feb-75	225		225	100	225		4			180			D	PROD	Cluff		
1323	B(42-02) 32ACA	GWSI	370001112313701	364,067	4,095,992	30-Apr-75	225	1	225	100	225	225	4	4,840	10-Aug-76	50	4,790		W	D	Veda Cluff		
1324	B(42-02) 32ACB	Wells 35	14133	363,810	4,095,633	30-Jan-72	196		137				11			33		32	S	PROD	Mace		
1325	B(42-02) 32BAA	Wells 55	603670	363,611	4,095,903	01-Mar-75	210		137				10			35		35	PROD	I	Mace,R G		
1326	B(42-02) 32BAA	Wells 55	603671	363,611	4,095,903	01-Apr-78	215		156				8			35		100	PROD	I	Mace,R G		
1327	B(42-02) 32BAA	Wells 35	14134	363,611	4,095,903	01-Nov-77	115		115				8			35		125	I	PROD	Mace		
1328	B(42-02) 32BAA	Wells 35	14135	363,611	4,095,903	01-Nov-77	115		115				8			35		125	I	PROD	Mace		
1329	B(42-02) 32BCC	Wells 55	629507	363,003	4,095,510	18-Sep-79	260		162				6			35			PROD	D	Mace,J F		
1329	B(42-02) 32BCC	GWSI	365955112321701	363,075	4,095,823	18-Sep-79	260		162			260	6	4,760	2-May-89	31	4,730		U	U	Ronald Mace	Y	
1330	B(42-02) 32BDB	GWSI	370000112320201	363,449	4,095,972	30-Jan-76	196		137	137	196	196	10.75	4,800	30-Jan-76	33	4,767	32	W	D	Ronald Mace		
1331	B(42-06) 31CBA	Wells 55	508056	323,020	4,096,118	27-Mar-85	700		674				9			200		170	PROD	D	Twin City Water Wks,		
1332	B(42-06) 31CCC	GWSI	365931112592301	322,857	4,095,696	01-Dec-87	585		585	480	580	585	8	4,965					W	MUN	Twin Cities Water Co		D
1332	B(42-06) 31CCC	Wells 55	516881	322,823	4,095,720	01-Dec-87	585		585				8			481		170	PROD	D	Twin City Wtr Works,		
1333	B(42-06) 31DDC	Wells 55	531800	324,029	4,095,697	08-Sep-91	635		540				8			535			PROD	D	Twin City Water Co,		
1334	B(42-11) DB	AOGC		281,476	4,097,097	01-Mar-82	1,432							2,890						DH	Kolob Petroleum		
1335	B(42-8) CC	AOGC		303,670	4,096,356	01-Jan-09	936							4,410						DH	Ariz & Utah Consol		

Abbreviations:
Wells35 = pre-1980 well registry system created by the Arizona State Land Department
Wells55 = current ADWR registry of wells
AOGC = Arizona Oil and Gas Conservation Commission
ADWR = Arizona Department of Water Resources
GWSI = Groundwater Site Inventory (maintained by ADWR)
NAD 83 = North American Datum, 1983; wells plotted in Zone 12N
UTM = Universal Transverse Mercator map projection
ft, bls = feet below land surface
gpm = gallons per minute

Well/Water Use:
C = Commercial
CA = Cathodic
D = Domestic
DH = Dry Hole
G = Geotechnical
I = Irrigation
IND = Industrial
JA = Test Hole, Junked and Abandoned
K = Other (Exploration)
ME = Mineral Exploration
MIN = Mining
MON = Monitor/Observation
MUN = Municipal/Public Supply
NONE = No water use
OG = Oil and/or Gas
PROD = Production
PZ = Piezometer
REC = Recreation
S = Stock
STRAT = Stratigraphic Test
T = Test
TA = Test Well, Temporarily Abandoned
U = Unused
UND = Undetermined
UTIL = Utility (Water Co)
W = Withdrawal
WD = Waste Disposal
WW = Test Well, converted to water well
X = Well Abandoned or Destroyed

Log Type:
D = Driller's
E = Electric
G = Geologist's/Lithologic
GM = Gamma Ray
GMG = Gamma - Gamma
I = Induction
N = Neutron
T = Temperature

Appendix E

SUMMARY OF LOCATION AND DISCHARGE FOR SPRINGS, SEEPS, AND STREAMS

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1	BLM-Legacy	LEG-199		Trailap Spring; B-41-01 07AA		North	Kanab Plateau - North	Mesozoic	Spring				36.97426	-112.4348	01-Jul-85	01-Jul-85	0.1	0.1	0.1	1	BLM 2010d	Flow Actually 0.03 Gallons per Minute/ Highway Allotment #5309
2	GCWC-02-Map	M-452		B-40-03 32		North	Kanab Plateau - North	Mesozoic	Spring				36.82497	-112.63856							Grand Canyon Wildlands Council 2002	No Spring on Topo
3	BLM_Field_Inv	BULR		Bulrush Seeps; B-39-04 14B		North	Kanab Plateau - North	Mesozoic	Spring		Perennial		36.7843187055	-112.69486883	23-Aug-85	23-Aug-85	0.15	0.15	0.15	1	BLM 2010d	
4	GWSI-1	363853113004001	1	Cunningham Spring; B-38-07 35DBD		North	Uinkaret Plateau - Central	Mesozoic	Spring	Moenkopi Fm		Seepage of Filtration	36.648040117	-113.011877158							ADWR 2009b	
4	NWIS-2	363853113004001	2	B-38-07 35DBD		North	Uinkaret Plateau - Central	Mesozoic	Spring	Moenkopi Fm			36.64803967	-113.0118773							USGS 2010b	
5	GWSI-1	364352112563301	1	Yellowstone Spring; B-39-06 33DCC		North	Yellowstone Mesa	Mesozoic	Spring	Shinarump Mbr		Contact	36.731096453	-112.94326452	15-Aug-51	15-Aug-51	1	1	1	1	ADWR 2009b	
5	NWIS-2	364352112563301	2	B-39-06 33DCC		North	Yellowstone Mesa	Mesozoic	Spring	Shinarump Mbr			36.73109657	-112.9432645							USGS 2010b	
5	BLM-Legacy	LEG-165	3	Yellowstone Spring; B-39-06 33DC		North	Yellowstone Mesa	Mesozoic	Spring				36.73102	-112.94299	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	Source on Private Land/ First Trough on State-- Last Trough on Public/ Yellowstone Allotment #5215,Esplin
6	GCWC-02-Map	M-400	1	Yellowstone Spring (source); B-38-06 04AB		North	Yellowstone Mesa	Mesozoic	Spring				36.72789	-112.94245							Grand Canyon Wildlands Council 2002	
6	NURE	GCBE501R	2			North	Yellowstone Mesa	Mesozoic	Spring	PRMN Ss			36.727785414	-112.942764435							USGS 2009b	
7	NURE	GCAE511R				North	Yellowstone Mesa	Mesozoic	Spring	TRSS Carbonate			36.781685749	-112.846560931							USGS 2009b	
8	BLM-Legacy	LEG-142		Moonshine Spring; B-39-05 17ADD		North	Yellowstone Mesa	Mesozoic	Spring				36.78172	-112.84672	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	Spring Flow .283 Gallons per Minute/75' Tunnel,Steel Water Trough 300 Gallons 20' of 3/4 Pipe Year 5-19-60/Report 1985: Bezanson,Schoppman (Old Trough and Pipeline Coming Down Fro
41	BLM-Legacy	LEG-138	1	Clearwater Spring; B-39-03 21AB		North	Kanab Creek - Central	Perched	Spring		Perennial		36.77161	-112.61696	08-Jun-82	08-Jun-82	5.8	5.8	5.8	1	BLM 2010d	Possible Two Sources of Water Flow
41	NWIS-2	364606112371201	2	Clearwater Spring; B-39-03 21BDD		North	Kanab Creek - Central	Perched	Spring	Kaibab Ls			36.7683206	-112.6207512	28-Aug-09	28-Aug-09	1.4	1.4	1.4	1	USGS 2010b	
41	SIR-2010-5025	364606112371201	3	Clearwater Spring; B-39-03 21BDD		North	Kanab Creek - Central	Perched	Spring				36.769972	-112.620083							Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
42	BLM-Legacy	LEG-93		Water Canyon Seep #3; B-38-03 05DA		North	Kanab Creek - Central	Perched	Spring				36.7211389	-112.631242	25-Oct-85	25-Oct-85	1.4	1.4	1.4	1	BLM 2010d	
43	BLM-Legacy	LEG-92		Water Canyon Seep #2; B-38-03 05DA		North	Kanab Creek - Central	Perched	Spring		Intermittent		36.722033	-112.63437	25-Oct-85	25-Oct-85	0	0	0	1	BLM 2010d	Dry at Time of Inventory/ No Flow
44	BLM-Legacy	LEG-95	1	Upper Water Canyon Spring; B-38-03 05AC		North	Kanab Creek - Central	Perched	Spring		Perennial		36.72327	-112.6352	09-Jun-82	09-Jun-82	0.75	0.75	0.75	1	BLM 2010d	
44	BLM-Legacy	LEG-91	2	Water Canyon Seep #1; B-38-03 05DA		North	Kanab Creek - Central	Perched	Spring				36.72327	-112.6352							BLM 2010d	
45	BLM-Legacy	LEG-94		Lower Water Canyon Spring; B-38-03 04CB		North	Kanab Creek - Central	Perched	Spring		Perennial		36.72092	-112.62714	08-Jun-82	08-Jun-82	0.75	0.75	0.75	1	BLM 2010d	Good Relict Area/No Cattle Use
46	BLM-Legacy	LEG-60		Bessie Spring Lower; B-36-04 24AC		North	Kanab Creek - Lower	Perched	Spring				36.50661	-112.6755	29-Aug-84	29-Aug-84	1.073	1.073	1.073	1	BLM 2010d	Area of Both Upper and Lower Bessie Spring Unsurveyed/ 7.5 Not Available
47	BLM-Legacy	LEG-58		Bessie Spring Upper; B-36-04 23DD		North	Kanab Creek - Lower	Perched	Spring		Perennial		36.5021	-112.68322	27-May-82	27-May-82	0.5	0.5	0.5	1	BLM 2010d	Preston Allotment #5224 Kanab Gulch
48	BLM-Legacy	LEG-68	1	Grama Spring; B-37-03 19CBC		North	Kanab Plateau - South	Perched	Spring		Perennial		36.58928	-112.66362	24-May-82	24-May-82	0.4	0.4	0.4	1	BLM 2010d	20' of 2" Pipe Pvc Feeds Two Troughs: 1) 300 Gallons, 2) 500 Gallons
48	NWIS-2	363521112394601	2	Grama Spring; B-37-03 19 Unsurveyed		North	Kanab Plateau - South	Perched	Spring	Holocene Alluvium			36.5891516	-112.6635274							USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
49	BLM-Legacy	LEG-69	1	Willow Spring; B-37-04 33BC		North	Kanab Plateau - South	Perched	Spring		Perennial		36.56595	-112.73593	07-Jun-82	03-Mar-88	0.4	0.4	0.4	1	BLM 2010d	Water Piped from Dugout Area to Nearby Cement Trough 10' × 4' × 1.5"
49	SIR-2010-5025	363357112440801	2	Willow Spring; B-37-04 33 Unsurveyed		North	Kanab Plateau - South	Perched	Spring				36.565861	-112.735944							Bills et al. 2010	North Segregation/East Kanab Basin Springs - Reclaimed Mine Area (Pigeon Mine on East and Hack and Hermit Mines on West)
49	NWIS-2	363357112440801	3	Willow Spring; B-37-04 33 Unsurveyed		North	Kanab Plateau - South	Perched	Spring				36.56581779	-112.736308							USGS 2010b	
49	D&M-85	Willow-Sp	4	Willow Spring		North	Kanab Plateau - South	Perched	Spring				36.56581779	-112.736308							Dames & Moore 1985	Data from Unpublished? Report Provided By Blm for Quarterly Sampling Conducted in 1983
49	EFN-90a	Pinenut-Willow	5	Willow Springs		North	Kanab Plateau - South	Perched	Spring				36.565861	-112.735944							Energy Fuels Nuclear Inc. 1990a	Used coordinates from SIR2010-5025 for Willow Spring
50	BLM-Legacy	LEG-57		South Water Canyon Spring; B-36-04 07AA		North	Kanab Plateau - South	Perched	Spring		Perennial		36.5399	-112.75583	08-Jun-82	08-Jun-82	0.5	0.5	0.5	1	BLM 2010d	Cement Dam in Front of 20' Tunnel/Pipe from Dam to Trough: 3' × 7' × 1'
51	BLM-Legacy	LEG-59		Unnamed seep (South Water Canyon); B-36-04 07C		North	Kanab Plateau - South	Perched	Spring		Ephemeral		36.532798895	-112.7668668	07-Jun-82	07-Jun-82	0.05	0.05	0.05	1	BLM 2010d	Water Canyon Pasture Heaton Cattle Co., Allotment #5221:Instream 95%,Wildlife 5%,Total Flow <0.1 Gallons per Minute/ Wet Area:W=6' L-12"/ Distchlus, Elymus, Chryso, Atca
52	BLM-Legacy	LEG-70		Buck Pasture Spring; B-37-05 15BC		North	Kanab Plateau - South	Perched	Spring		Intermittent		36.60715	-112.82534	01-Jul-85	01-Jul-85	0	0	0	1	BLM 2010d	Spring Dry at Time of Inspection/Signs of Development at One Tome/Severe Disrepair/Jdr Description:Tunnel 40' × 6' × 4' With 100' of 1 1/2 Pipe to Wooden Trough 14' × 20" × 14"
53	BLM-86	WaterCyn-Seep		Small seep at confluence of Water and Hack's Canyon		North	Kanab Plateau - South	Perched	Spring	Supai Fm (Esplanade)			36.5612	-112.75794							BLM 1986	Described as being 4.6 miles North of Pinenut Mine, at Water Canyon Entrance
54	NWIS-2	364327112303101	1	Pigeon Spring; B-38-02 04ACA		North	Snake Gulch	Perched	Spring	Kaibab Ls			36.7241547	-112.5093567							USGS 2010b	
54	Hopkins-84b	KAN003W	2	Pigeon Spring		North	Snake Gulch	Perched	Spring				36.724154743	-112.50935673							Hopkins et al. 1984b	
54	GCWC-02-Map	M-387	3	Pigeon Spring; B-38-02 04A		North	Snake Gulch	Perched	Spring				36.72427	-112.50925							Grand Canyon Wildlands Council 2002	
55	GCWC-02-Map	M-388		B-38-02 03		North	Snake Gulch	Perched	Spring				36.7224	-112.49496							Grand Canyon Wildlands Council 2002	No Spring on Topo
74	EFN-88b	SW-KC4		Kanab Creek Downstream from Kanab North Mine		North	Kanab Creek - Central	N/A	Stream				36.67967	-112.63296	22-Nov-82	10-Sep-87	386	28187	8074.5	4	Energy Fuels Nuclear 1988b	
75	EFN-88b	SW-KC5		Kanab Creek Upstream from Kanab North Mine		North	Kanab Creek - Central	N/A	Stream				36.68993	-112.62989	22-Nov-82	10-Sep-87	857	29309	8753.5	4	Energy Fuels Nuclear 1988b	
76	EFN-88b	SW-KC6		Kanab Creek Downstream from Clearwater Spring		North	Kanab Creek - Central	N/A	Stream				36.7698	-112.62076							Energy Fuels Nuclear 1988b	
77	EFN-88b	SW-KC2		Kanab Creek Upstream from Hack Canyon		North	Kanab Creek - Lower	N/A	Stream				36.56195	-112.64723	22-Nov-82	10-Sep-87	189	26122	7800.75	4	Energy Fuels Nuclear 1988b	
79	NWIS-2	365338112394501	1	Sand Spring; B-40-03 06CBC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Moenkopi Fm			36.89387477	-112.6632573							USGS 2010b	
79	GCWC-02-Map	M-449	2	Sand Spring; B-40-03 06C		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.89371	-112.6629							Grand Canyon Wildlands Council 2002	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
80	NWIS-2	365142112344901	1	Quick Water Spring; B-40-03 14DAC UNSURVEYED		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Moenkopi Fm			36.86165347	-112.5810313							USGS 2010b	
80	GCWC-02-Map	M-450	2	Quick Water Spring; B-40-03 14DCC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.86151	-112.58107							Grand Canyon Wildlands Council 2002	
81	GCWC-02-Map	M-451	1	Two Mile Seep; B-40-03 19CCD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.84676	-112.66112							Grand Canyon Wildlands Council 2002	
81	NWIS-2	365047112394201	2	B-40-03 19CCD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Moenkopi Fm			36.84637516	-112.6624222							USGS 2010b	
82	GCWC-02-Map	M-131	1	B-40-04 04A (seep)		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.89903	-112.72198							Grand Canyon Wildlands Council 2002	
82	NWIS-2	365353112431201	2	B-40-04 04ADD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Quaternary Alluvium			36.89804098	-112.720759							USGS 2010b	
83	GCWC-02-Map	M-467	1	Sixmile Spring; B-41-03 12CCC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.96233	-112.57558							Grand Canyon Wildlands Council 2002	
83	NWIS-2	365747112343001	2	B-41-03 12CCB UNSURVEYED		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr			36.96304145	-112.5757576							USGS 2010b	
83	NURE	GCAF502R	3			North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	TRSS Clastics - Coarse			36.962285893	-112.576457553							USGS 2009b	
84	GWSI-1	365452112453901	1	Sheep Dip Spring; B-41-04 31ABD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Navajo Ss	Perennial	Fracture and Depression	36.914429068	-112.761593828							ADWR 2009b	
84	NWIS-2	365452112453901	2	B-41-04 31ABD2		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Navajo Ss			36.9144295	-112.7615942							USGS 2010b	
85	NWIS-2	365424112442901		B-41-04 32DDB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Quaternary Alluvium			36.90665187	-112.7421488							USGS 2010b	
86	NWIS-2	365215112442501		Pipe Springs		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.8708333	-112.7402778							USGS 2010b	
87	NWIS-2	365308112472301		Wooley Spring		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.88554077	-112.7904834							USGS 2010b	
88	GCWC-02-Map	M-183	1	Wooley Spring; B-40-05 12DB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.88096	-112.78097							Grand Canyon Wildlands Council 2002	
88	NURE	GCAE517R	2			North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.881085257	-112.78116065							USGS 2009b	
89	GCWC-02-Map	M-458		Meeks Spring; B-41-05 34CD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.90375	-112.8247							Grand Canyon Wildlands Council 2002	
90	GCWC-02-Map	M-175		Upper Moccasin Spring; B-41-05 35ABB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.91541	-112.80287							Grand Canyon Wildlands Council 2002	
91	GCWC-02-Map	M-477		Upper Moccasin Spring; B-41-05 35ADD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.91237	-112.79726							Grand Canyon Wildlands Council 2002	
92	GCWC-02-Map	M-453		South Moccasin Seep; B-40-04 04B		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.90053	-112.73352							Grand Canyon Wildlands Council 2002	
93	GCWC-02-Map	M-454		B-40-04 05		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring				36.89668	-112.74663							Grand Canyon Wildlands Council 2002	No Spring on Topo
94	BLM-Legacy	LEG-252	1	Johnson Spring; A-42-01 31DD		North Buffer	Kanab Plateau - North	Mesozoic	Spring				36.9908	-112.32415							BLM 2010d	Flow Rate Undetermined Due to Plugged Line (01-10-83)
94	NURE	GCAG501R	2			North Buffer	Kanab Plateau - North	Mesozoic	Spring	MNKP Sh			36.989586082	-112.324149918							USGS 2009b	
95	BLM-Legacy	LEG-225		Cow Seep; B-41-02 01AB		North Buffer	Kanab Plateau - North	Mesozoic	Spring				36.98753	-112.45672	31-Jul-85	31-Jul-85	0	0	0	1	BLM 2010d	No Measurement of Seep/ Dry at Time of Inventory (07-31-85)/Old Rusted 1" Steel Pipe for 100 Yards,Broken Up

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
96	BLM-Legacy	LEG-254		Juniper Seep; B-42-02 36CA		North Buffer	Kanab Plateau - North	Mesozoic	Spring				36.99213	-112.46223	31-Jul-85	31-Jul-85	0	0	0	1	BLM 2010d	Seep Dry at Time of Inventory (07-31-85)/ No Flow Measured/ Undeveloped
97	BLM-Legacy	LEG-226		Shinarump Seep; B-41-02 01BBA		North Buffer	Kanab Plateau - North	Mesozoic	Spring				36.98981	-112.45965	01-Jul-85	01-Jul-85	0.1	0.1	0.1	1	BLM 2010d	Permittee:Judd/Seep Flow 0.05/1" Pipe to Drain Tunnel Pool 1/2" Used to Drain Middle--Both Long Since Destroyed
98	BLM-Legacy	LEG-253		B-42-02 36DB (seep)		North Buffer	Kanab Plateau - North	Mesozoic	Spring				36.91268	-112.46035	01-Jul-85	01-Jul-85	0	0	0	1	BLM 2010d	Seep=Damp/No Flow Measured/100% Instream
99	NHD-1	78328951				North Buffer	Kanab Plateau - North	Mesozoic	Spring				37.0114110092	-112.422708869							USGS 2007	
100	NHD-1	78328967				North Buffer	Kanab Plateau - North	Mesozoic	Spring				37.0318954759	-112.268100803							USGS 2007	
101	GWSI-1	365149112442201	1	Pipe Spring; B-40-04 17DDB		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss	Perennial	Fracture	36.863124516	-112.740341567							ADWR 2009b	
101	NWIS-2	365149112442201	2	B-40-04 17DDB		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss			36.8635966	-112.740203	27-Jul-76	10-Jun-08	34.9	34.9	34.9	1	USGS 2010b	
101	GCWC-02	PSNM-2	3	Pipe (Fort) Spring; B-40-04 17DD		North Buffer	Moccasin Mountains	Mesozoic	Spring	Chinle Fm		Fault	36.86311	-112.73964	08-Aug-00	08-Aug-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Central Arizona Strip, Northern Edge, in Pipe Springs National Monument
102	NWIS-2	365149112442202		B-40-04 17DDB2		North Buffer	Moccasin Mountains	Mesozoic	Spring				36.8635966	-112.740203							USGS 2010b	
103	NWIS-2	365149112442203		B-40-04 17DDB3		North Buffer	Moccasin Mountains	Mesozoic	Spring				36.8635966	-112.740203							USGS 2010b	
104	GWSI-1	365438112453501	1	Long Res Spring; B-41-04 31ADC		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss	Perennial	Fracture	36.910541099	-112.760482673	24-Jun-72	09-Sep-76	89.2	90	89.6	2	ADWR 2009b	
104	NWIS-2	365438112453501	2	B-41-04 31ADC		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss			36.91054066	-112.7604829	17-Jan-69	17-Jan-69	89	89	89	1	USGS 2010b	
105	GWSI-1	365435112460301	1	Mocassin Spring; B-41-04 31CAB		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss	Perennial	Fracture	36.909707092	-112.768260949	17-Jan-69	09-Sep-76	23	42.85	32.925	2	ADWR 2009b	
105	NWIS-2	365435112460301	2	B-41-04 31CAB		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss			36.9097073	-112.7682609							USGS 2010b	
106	GCWC-02-Map	M-473	1	Moccasin Spring; B-41-04 31DBB		North Buffer	Moccasin Mountains	Mesozoic	Spring				36.91008	-112.7631							Grand Canyon Wildlands Council 2002	
106	GWSI-1	365436112454501	2	Sand Spring; B-41-04 31DBA		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss	Perennial	Fracture	36.909985097	-112.763260764							ADWR 2009b	
106	NWIS-2	365436112454501	3	B-41-04 31DBA2		North Buffer	Moccasin Mountains	Mesozoic	Spring	Navajo Ss			36.9099851	-112.7632608							USGS 2010b	
106	NURE	GCAE508R	4			North Buffer	Moccasin Mountains	Mesozoic	Spring	TRSS Ss			36.909385106	-112.761560681							USGS 2009b	
107	NWIS-2	365433112461001		Upper Moccasin unnamed spring		North Buffer	Moccasin Mountains	Mesozoic	Spring				36.90915176	-112.7702055							USGS 2010b	
108	GCWC-02	PSNM-1		West Cabin Spring; B-40-04 17DD		North Buffer	Moccasin Mountains	Mesozoic	Spring	Chinle Fm	Perennial	Fault	36.86322	-112.74023	08-Aug-00	08-Aug-00	0.48	0.48	0.48	1	Grand Canyon Wildlands Council 2002	Central Arizona Strip, Northern Edge, in Pipe Springs National Monument
109	GCWC-02	PSNM-3		Tunnel Spring; B-40-04 17DD		North Buffer	Moccasin Mountains	Mesozoic	Spring	Chinle Fm	Perennial	Fault	36.86311	-112.73964	08-Aug-00	08-Aug-00	11.3	11.3	11.3	1	Grand Canyon Wildlands Council 2002	Central Arizona Strip, Northern Edge, in Pipe Springs National Monument
110	NHD-1	78328767				North Buffer	Moccasin Mountains	Mesozoic	Spring				36.8874286761	-112.859930469							USGS 2007	
111	NHD-1	78328733				North Buffer	Moccasin Mountains	Mesozoic	Spring				36.8917288094	-112.863311869							USGS 2007	
112	NHD-1	126746163				North Buffer	Moccasin Mountains	Mesozoic	Spring				36.9035566761	-112.847525402							USGS 2007	
113	GCWC-02-Map	M-79		B-39-08 05ABB		North Buffer	Uinkaret Plateau - Central	Mesozoic	Spring				36.81817	-113.17721							Grand Canyon Wildlands Council 2002	
114	GCWC-02-Map	M-478		B-41-06 03		North Buffer	Uinkaret Plateau - North	Mesozoic	Spring				36.89658	-112.92687							Grand Canyon Wildlands Council 2002	No Spring on Topo

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
115	GWSI-1	362457113080001	1	Coyote Spring; B-35-08 22DBD		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows	Perennial	Contact	36.415814435	-113.134100092	16-Aug-50	16-Aug-50	0.5	0.5	0.5	1	ADWR 2009b	
115	NWIS-2	362457113080001	2	B-35-08 22DBD		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows			36.41581477	-113.1341004							USGS 2010b	
115	BLM-Legacy	LEG-43	3	Coyote Spring; B-35-08 22D		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring				36.41568	-113.13422							BLM 2010d	Flow Not Available/Piped to House
116	GWSI-1	362408113084601	1	Nixon Spring; B-35-08 27CBC		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows	Perennial	Contact	36.402203357	-113.146878325	16-Aug-50	16-Aug-50	1	1	1	1	ADWR 2009b	
116	NWIS-2	362408113084601	2	B-35-08 27CBC		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows			36.40220358	-113.1468784							USGS 2010b	
116	GCWC-02	BLM 187	3	Nixon Spring; B-35-08 27CB		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basalt	Perennial	Contact; Fracture	36.4022	-113.14653	20-Jun-00	14-Aug-01	0.3	1.4	0.85	2	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, South Slope of Mt. Trumbull
116	BLM-Legacy	LEG-44	4	Nixon Spring; B-35-08 27CB		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring				36.4022	-113.14653	01-May-85	01-Jul-85	2.2	5.56	3.88	2	BLM 2010d	Flow Was 5.56 Gallons per Minute on 05-01-85/Source Location-Langs Run
117	NURE	GCCD501R				North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	UNKN Volcanics -Mafic			36.392481318	-113.151767281							USGS 2009b	
118	BLM-Legacy	LEG-45		Orson Spring; B-35-08 23CDB		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring				36.41392	-113.12228	01-Jul-85	01-Jul-85	1.9	1.9	1.9	1	BLM 2010d	Spring Completely Buried at Source
119	GCWC-02-Map	M-44		Hualapais Spring; B-37-08 31		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring				36.56488	-113.20001							Grand Canyon Wildlands Council 2002	
120	NHD-1	78329017				North Buffer	Vermilion Cliffs (UT)	Mesozoic	Spring				37.0500028092	-112.438913203							USGS 2007	
121	NHD-1	78328991				North Buffer	Vermilion Cliffs (UT)	Mesozoic	Spring				37.0574402758	-112.477864469							USGS 2007	
181	GCWC-02-Map	M-42	1	Hotel Spring; B-34-04 07A		North Buffer	150-mile Canyon	Perched	Spring				36.36401	-112.75762							Grand Canyon Wildlands Council 2002	
181	SIR-2010-5025	362157112451601	2	Hotel Spring; B-34-04 07 UNSURVEYED		North Buffer	150-mile Canyon	Perched	Spring				36.365972	-112.753639							Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
181	NWIS-1	362157112451601	3	Hotel Spring		North Buffer	150-mile Canyon	Perched	Spring				36.36583333	-112.75444444							USGS 2009a	
182	GCWC-02-Map	M-309	1	Buckhorn Spring; B-34-05 01BA		North Buffer	150-mile Canyon	Perched	Spring				36.38236	-112.77933							Grand Canyon Wildlands Council 2002	
182	NWIS-1	362258112464701	2	Buckhorn Spring		North Buffer	150-mile Canyon	Perched	Spring				36.38277778	-112.77972222							USGS 2009a	
183	GCWC-02-Map	M-51		Little Joe Spring; B-34-04 06DDD		North Buffer	150-mile Canyon	Perched	Spring				36.36872	-112.75409							Grand Canyon Wildlands Council 2002	
184	GCWC-02-Map	M-105		B-34-04 08C		North Buffer	150-mile Canyon	Perched	Spring				36.35675	-112.748							Grand Canyon Wildlands Council 2002	
185	GCWC-02-Map	M-308		North Spring; B-35-04 34ADD		North Buffer	150-mile Canyon	Perched	Spring				36.39143	-112.7001							Grand Canyon Wildlands Council 2002	
186	GCWC-02-Map	M-336	1	Lower Jumpup Spring; B-36-03 11BD		North Buffer	Jumpup Canyon	Perched	Spring				36.53765	-112.58523							Grand Canyon Wildlands Council 2002	
186	SIR-2010-5025	363209112350801	2	Lower Jumpup Spring; B-36-03 11		North Buffer	Jumpup Canyon	Perched	Spring				36.532111	-112.586833	28-Aug-09	28-Aug-09	57.6	57.6	57.6	1	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
186	NWIS-1	363209112350801	3	Lower Jumpup Spring		North Buffer	Jumpup Canyon	Perched	Spring				36.53583333	-112.58555556							USGS 2009a	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
187	SIR-2010-5025	363115112342601	1	Mountain Sheep Spring; B-36-03 13		North Buffer	Jumpup Canyon	Perched	Spring				36.52325	-112.567361							Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
187	GCWC-02-Map	M-446	2	Mountain Sheep Spring; B-36-03 13BDB		North Buffer	Jumpup Canyon	Perched	Spring				36.52314	-112.56757							Grand Canyon Wildlands Council 2002	
188	SIR-2010-5025	363450112325001	1	Upper Jumpup Spring; B-37-02 30		North Buffer	Jumpup Canyon	Perched	Spring				36.58075	-112.546778	27-Aug-09	27-Aug-09	1.3	1.3	1.3	1	Bills et al. 2010	North Segregation/ East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
188	NWIS-1	363450112325001	2	Upper Jumpup Spring		North Buffer	Jumpup Canyon	Perched	Spring				36.58055556	-112.54722222							USGS 2009a	
189	NWIS-1	363115112342601				North Buffer	Jumpup Canyon	Perched	Spring				36.52083333	-112.57388889							USGS 2009a	
190	GCWC-02-Map	M-330		Bitter Spring; B-36-02 07C		North Buffer	Jumpup Canyon	Perched	Spring				36.52687	-112.55209							Grand Canyon Wildlands Council 2002	
191	GCWC-02-Map	M-329		Cottonwood Spring; B-36-02 18AB		North Buffer	Jumpup Canyon	Perched	Spring				36.52602	-112.54557							Grand Canyon Wildlands Council 2002	
192	GCWC-02-Map	M-47		Indian Hollow Spring; B-36-03 25BDD		North Buffer	Jumpup Canyon	Perched	Spring				36.49181	-112.56599							Grand Canyon Wildlands Council 2002	Usgs Coordinates Listed as X="362051/362039.25" and Y="4037069/4037044.8"
193	GCWC-02-Map	M-33		Forgotten Canyon Spring; B-36-03 25		North Buffer	Jumpup Canyon	Perched	Spring				36.49067	-112.57161							Grand Canyon Wildlands Council 2002	
194	GCWC-02-Map	M-58		Lower Forgotten Canyon Spring; B-36-03 24		North Buffer	Jumpup Canyon	Perched	Spring				36.49046	-112.57426							Grand Canyon Wildlands Council 2002	
195	GCWC-02-Map	M-365		Jumpup Spring; B-37-02 30DBB		North Buffer	Jumpup Canyon	Perched	Spring				36.57686	-112.54879							Grand Canyon Wildlands Council 2002	
196	GCWC-02-Map	M-50		Kwagunt Hollow Spring; B-36-02 19		North Buffer	Jumpup Canyon	Perched	Spring				36.50193	-112.5477							Grand Canyon Wildlands Council 2002	
197	Springs_0103	INDHOL		Indian Hollow Spring		North Buffer	Jumpup Canyon	Perched	Spring				36.4706133069	-112.540571187							BLM 2010c	
198	GWSI-1	364143112184501	1	Warm Springs; A-38-01 17ACA		North Buffer	Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact	36.695267514	-112.31323707							ADWR 2009b	
198	GCWC-02	KNF-23	2	Warm Springs; A-38-01 17AC		North Buffer	Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact; Fracture	36.69539	-112.31275	03-Jul-00	03-Jul-00	5.7	5.7	5.7	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, Warm Springs Canyon, Five Miles West of Jacobs Lake
198	NWIS-2	364143112184501	3	A-38-01 17ACA		North Buffer	Kaibab Plateau	Perched	Spring	Coconino Ss			36.69526729	-112.313237							USGS 2010b	
198	NURE	GCBG503R	4			North Buffer	Kaibab Plateau	Perched	Spring	UNKN Ss			36.695289524	-112.311937017							USGS 2009b	
199	GCWC-02-Map	M-376		Oak Spring; A-38-01 19C		North Buffer	Kaibab Plateau	Perched	Spring				36.67567	-112.3367							Grand Canyon Wildlands Council 2002	
200	GCWC-02-Map	M-373		Tilton Springs; A-38-01 30CC		North Buffer	Kaibab Plateau	Perched	Spring				36.65881	-112.3388							Grand Canyon Wildlands Council 2002	
201	GCWC-02-Map	M-344		Moquitch Spring; A-37-01 06DA		North Buffer	Kaibab Plateau	Perched	Spring				36.63363	-112.32575							Grand Canyon Wildlands Council 2002	
202	BLM-Legacy	LEG-56		Daves Canyon Spring; B-36-03 30CC		North Buffer	Kanab Creek - Lower	Perched	Spring		Perennial		36.48655	-112.66276	28-May-82	29-Aug-84	0.3	0.75	0.525	2	BLM 2010d	Spring Flow Actually 0.26 Gallons per Minute
203	BLM-Legacy	LEG-40		B&H Spring; B-35-04 12AB		North Buffer	Kanab Creek - Lower	Perched	Spring				36.45347	-112.67153	29-Aug-84	29-Aug-84	1.4	1.4	1.4	1	BLM 2010d	No Access to Livestock,Only Wildlife/ Located on Grand Canyon National Park

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
204	BLM-Legacy	LEG-42		Dripping Spring North; B-35-04 12CC		North Buffer	Kanab Creek - Lower	Perched	Spring		Intermittent		36.4434	-112.6753	07-Jun-82	07-Jun-82	0.75	0.75	0.75	1	BLM 2010d	Spring is Located Inside Grand Canyon National Park Boundary/Estimated Flow Rate 0.75 Gallons per Minute/Average Could Be Perrinial Seep/No 7.5 Minute Quads for This Area/Us
205	BLM-Legacy	LEG-41		Dripping Spring South; B-35-04 13BB		North Buffer	Kanab Creek - Lower	Perched	Spring		Intermittent		36.43946	-112.67862	07-Jun-82	07-Jun-82	0.5	0.5	0.5	1	BLM 2010d	Sheep Use/Inside Grand Canyon National Park Boundary
206	GCWC-02-Map	M-63		Maidenhair Spring; B-36-03 18		North Buffer	Kanab Creek - Lower	Perched	Spring				36.52557	-112.65126							Grand Canyon Wildlands Council 2002	
207	GCWC-02-Map	M-180	1	Wildband Spring; B-38-02 04DC		North Buffer	Snake Gulch	Perched	Spring				36.71712	-112.51015							Grand Canyon Wildlands Council 2002	
207	NWIS-2	364259112303201	2	Wildband Spring; B-38-02 04DCD		North Buffer	Snake Gulch	Perched	Spring	Kaibab Ls			36.71637678	-112.5096344							USGS 2010b	
207	Hopkins-84b	KAN002W	3	Wildband Spring		North Buffer	Snake Gulch	Perched	Spring				36.716932299	-112.510189905							Hopkins et al. 1984b	
208	GCWC-02-Map	M-158	1	Rock Spring; B-38-03 24BB		North Buffer	Snake Gulch	Perched	Spring				36.68363	-112.57341							Grand Canyon Wildlands Council 2002	
208	SIR-2010-5025	364101112340601	2	Rock Spring; B-38-03 24		North Buffer	Snake Gulch	Perched	Spring				36.683722	-112.571833	02-Sep-09	02-Sep-09	0.11	0.11	0.11	1	Bills et al. 2010	North Segregation/East Kanab Basin Springs - Reclaimed Mine Area (Pigeon Mine on East and Hack and Hermit Mines on West)
208	Hopkins-84b	KAN005W	3	Rock Spring		North Buffer	Snake Gulch	Perched	Spring				36.684431245	-112.571858434							Hopkins et al. 1984b	
209	GCWC-02-Map	M-53	1	Little Slide Spring; B-38-03 25		North Buffer	Snake Gulch	Perched	Spring				36.65803	-112.56238							Grand Canyon Wildlands Council 2002	
209	SIR-2010-5025	363922112334501	2	Slide Spring; B-38-03 36		North Buffer	Snake Gulch	Perched	Spring				36.658028	-112.561639	27-Aug-09	27-Aug-09	89.8	89.8	89.8	1	Bills et al. 2010	North Segregation/East Kanab Basin Springs - Reclaimed Mine Area (Pigeon Mine on East and Hack and Hermit Mines on West)
209	NWIS-1	363922112334501	3			North Buffer	Snake Gulch	Perched	Spring				36.65611111	-112.5625							USGS 2009a	
209	Hopkins-84b	KAN001W	4	Slide Spring		North Buffer	Snake Gulch	Perched	Spring				36.658042065	-112.562968644							Hopkins et al. 1984b	
210	GCWC-02-Map	M-170	1	Table Rock Spring; B-38-02 12B		North Buffer	Snake Gulch	Perched	Spring				36.71141	-112.46396							Grand Canyon Wildlands Council 2002	
210	Hopkins-84b	KAN004W	2	Table Rock Spring		North Buffer	Snake Gulch	Perched	Spring				36.711099366	-112.464354608							Hopkins et al. 1984b	
211	GCWC-02-Map	M-176	1	Upper Willow Spring; B-38-02 08AC		North Buffer	Snake Gulch	Perched	Spring				36.70996	-112.52865							Grand Canyon Wildlands Council 2002	
211	Hopkins-84b	KAN006W	2	Willow Spring		North Buffer	Snake Gulch	Perched	Spring				36.709432002	-112.529357212							Hopkins et al. 1984b	Name from 100K Topo Map
212	GCWC-02-Map	M-394		Horse Spring; B-38-03 36BDD		North Buffer	Snake Gulch	Perched	Spring				36.65078	-112.56984							Grand Canyon Wildlands Council 2002	
213	GCWC-02-Map	M-393		Slide Spring; B-38-03 25		North Buffer	Snake Gulch	Perched	Spring				36.66369	-112.56586							Grand Canyon Wildlands Council 2002	
214	GCWC-02-Map	M-367		Little Spring; B-37-03 03D		North Buffer	Snake Gulch	Perched	Spring				36.63283	-112.59612							Grand Canyon Wildlands Council 2002	
215	NHD-1	GNIS-00007196		Little Spring		North Buffer	Snake Gulch	Perched	Spring				36.6295680765	-112.585678669							USGS 2007	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
216	GCWC-02-Map	M-161	1	Schmutz Spring; B-34-06 10DBB		North Buffer	Tuckup Canyon	Perched	Spring				36.36164	-112.91952							Grand Canyon Wildlands Council 2002	
216	SIR-2010-5025	362143112551201	2	Schmutz Spring; B-34-06 10 UNSURVEYED		North Buffer	Tuckup Canyon	Perched	Spring				36.362083	-112.919306							Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
216	NWIS-1	362143112551201	3	Schmutz Spring		North Buffer	Tuckup Canyon	Perched	Spring				36.36194444	-112.92							USGS 2009a	
217	GCWC-02-Map	M-271		Cottonwood Spring; B-34-06 22D		North Buffer	Tuckup Canyon	Perched	Spring				36.33028	-112.91858							Grand Canyon Wildlands Council 2002	
221	GWSI-1	362047112432901	1	B-34-04 16D		North Buffer	Grand Canyon - Central	Regional	Spring	Muav Ls			36.346371969	-112.725470752							ADWR 2009b	
221	NWIS-2	362047112432901	2	B-34-04 16D UNSURVEYED		North Buffer	Grand Canyon - Central	Regional	Spring	Muav Ls			36.34637186	-112.725471							USGS 2010b	
221	Peterson-77	CF-11	3	River Mile 151.5	151.5	North Buffer	Grand Canyon - Central	Regional	Spring	Muav Ls			36.346371871	-112.725470953	07-May-76	07-May-76	1	1	1	1	Peterson et al. 1977	
222	SIR-2010-5025	362802112374601	1	Kanab Spring; B-35-03 05-2		North Buffer	Kanab Creek - Lower	Regional	Spring				36.465528	-112.628694	26-Aug-09	26-Aug-09	274	274	274	1	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
222	NWIS-1	362802112374601	2			North Buffer	Kanab Creek - Lower	Regional	Spring				36.46722222	-112.62944444							USGS 2009a	
223	SIR-2010-5025	362723112382801	1	Shower Bath Spring; B-35-03 05-1		North Buffer	Kanab Creek - Lower	Regional	Spring				36.456806	-112.642667	26-Aug-09	26-Aug-09	202	202	202	1	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
223	NWIS-1	362723112382801	2	Showerbath Spring		North Buffer	Kanab Creek - Lower	Regional	Spring				36.45638889	-112.64111111							USGS 2009a	
224	SIR-2010-5025	362702112394701	1	Side Canyon Spring; B-35-04 12		North Buffer	Kanab Creek - Lower	Regional	Spring				36.450361	-112.663972	26-Aug-09	26-Aug-09	1	1	1	1	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
224	NWIS-1	362702112394701	2			North Buffer	Kanab Creek - Lower	Regional	Spring				36.45055556	-112.66305556							USGS 2009a	
225	EFN-88b	SW-KC3		Kanab Creek Downstream from Snake Gulch		North Buffer	Kanab Creek - Central	N/A	Stream				36.63593	-112.62643	22-Nov-82	10-Sep-87	467	31912	9867.5	4	Energy Fuels Nuclear 1988b	
226	EFN-88b	SW-KC1		Kanab Creek Downstream from HaCreek Canyon		North Buffer	Kanab Creek - Lower	N/A	Stream				36.54911	-112.65096	22-Nov-82	10-Sep-87	189	28860	8126.25	4	Energy Fuels Nuclear 1988b	
227	NWIS-1	361947112550200		Cottonwood Creek North Rim Grand Canyon		North Buffer	Tuckup Canyon	N/A	Stream				36.32972222	-112.91722222							USGS 2009a	
232	NHD-1	126013714				East	Lees Ferry Vicinity	Mesozoic	Spring				36.8101706095	-111.65786127							USGS 2007	
234	GCWC-02-Map	M-391		Rock Spring??; A-38-03 35CA		East	Kaibab Plateau	Perched	Spring				36.64848	-112.0467							Grand Canyon Wildlands Council 2002	
236	GWSI-1	365056111320101	1	01 029-01.85X10.42		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Navajo Ss			36.848877531	-111.534324602	18-Sep-59	18-Sep-59	5	5	5	1	ADWR 2009b	
236	NWIS-2	365056111320101	2	01 029-01.85X10.42		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Navajo Ss			36.8488774	-111.5343247							USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
237	GWSI-1	365150111343901	1	Lee's Ferry Spring; A-40-08 18DBC		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Chinle Fm			36.863876825	-111.57821557	01-Aug-59	01-Aug-59	0.3	0.3	0.3	1	ADWR 2009b	
237	NWIS-2	365150111343901	2	A-40-08 18DBC2		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Chinle Fm			36.8638767	-111.5782156							USGS 2010b	
238	Taylor-97	FROG-SP		Frog Marsh Spring (Below Dam)		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring				36.84580556	-111.55725							Taylor et al. 1997	
239	GCWC-02	GCNRA-1		Lees Ferry Spring; A-40-08 18DB		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Wingate Ss	Ephemeral	Contact	36.86667	-111.55833	13-Feb-02	13-Feb-02	0	0	0	1	Grand Canyon Wildlands Council 2002	Northeastern Arizona Strip at Lees Ferry, Az
240	GWSI-1	364557111360301	1	Navajo Spring; 03 029-05.59X16.13		East Buffer	Marble Platfrom	Mesozoic	Spring	Shinarump Mbr	Perennial	Seepage of Filtration	36.765821549	-111.60154737							ADWR 2009b	
240	NWIS-2	364557111360301	2	03 029-05.59X16.13		East Buffer	Marble Platfrom	Mesozoic	Spring	Shinarump Mbr			36.76582188	-111.6015477	30-Apr-52	30-Apr-52	8	8	8	1	USGS 2010b	
241	GWSI-1	363930111384501	1	Bitterspring; 03 044-08.12X06.27		East Buffer	Marble Platfrom	Mesozoic	Spring	Moenkopi Fm	Perennial	Seepage of Filtration	36.658321067	-111.646547548							ADWR 2009b	
241	NWIS-2	363930111384501	2	03 044-08.12X06.27		East Buffer	Marble Platfrom	Mesozoic	Spring	Moenkopi Fm			36.6583214	-111.6465479	30-Apr-52	30-Apr-52	3	3	3	1	USGS 2010b	
242	Springs_0103	NAV		Navajo Spring		East Buffer	Marble Platfrom	Mesozoic	Spring				36.7730723215	-111.618888052							BLM 2010c	
243	NHD-1	126006126				East Buffer	Marble Platfrom	Mesozoic	Spring				36.7235666763	-111.625973804							USGS 2007	
244	NHD-1	126013047				East Buffer	Marble Platfrom	Mesozoic	Spring				36.7854294762	-111.599279071							USGS 2007	
245	GWSI-1	365707112020301	1	Coyote Springs; A-41-03 13CBC		East Buffer	Paria Plateau	Mesozoic	Spring	Alluvium	Perennial	Perched	36.95192973	-112.03490272							ADWR 2009b	
245	NWIS-2	365707112020301	2	A-41-03 13CBC		East Buffer	Paria Plateau	Mesozoic	Spring	Holocene Alluvium			36.95193018	-112.0349024	06-Aug-76	06-Aug-76	1.22	1.22	1.22	1	USGS 2010b	
245	NURE	GCAH501R	3			East Buffer	Paria Plateau	Mesozoic	Spring	KBBL Carbonate			36.951585733	-112.03443569							USGS 2009b	
246	BLM-Legacy	LEG-232		Cottonwood Spring; A-41-04 08CAA		East Buffer	Paria Plateau	Mesozoic	Spring				36.96809	-111.99236	01-Jul-85	01-Jul-85	7	7	7	1	BLM 2010d	
247	BLM-Legacy	LEG-227		Pahole Seep; A-41-03 25AAD		East Buffer	Paria Plateau	Mesozoic	Spring				36.92878	-112.03141							BLM 2010d	
248	BLM-Legacy	LEG-230		Top Rock Spring; A-41-04 07AB		East Buffer	Paria Plateau	Mesozoic	Spring				36.9729	-112.00945							BLM 2010d	Spring in Disrepair/No Flow Rate Could Be Established Due to Nature of Spring Development
249	BLM-Legacy	LEG-193		Wilson Canyon Seeps; A-40-07 05AA		East Buffer	Paria Plateau	Mesozoic	Spring				36.90042	-111.66096	01-Apr-82	01-Apr-82	0.1	0.1	0.1	1	BLM 2010d	No Tds Report/Less Than Oil Flow
250	Springs_0103	PAWHOLE		Paw Hole		East Buffer	Paria Plateau	Mesozoic	Spring				36.9242520285	-112.016954309							BLM 2010c	
251	GWSI-1	364757111421501	1	Badger Spring; A-39-06 12BAD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.79915384	-111.70488612							ADWR 2009b	
251	NWIS-2	364757111421501	2	A-39-06 12BAD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.7991535	-111.7048858							USGS 2010b	
252	BLM-Legacy	LEG-145	1	Soap Creek Spring East; A-39-06 17DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.77792	-111.76996	03-Jul-88	03-Jul-88	7.8	7.8	7.8	1	BLM 2010d	
252	GWSI-1	364645111461301	2	Soap Creek Spring; A-39-06 17DAB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	Navajo Ss			36.779153482	-111.770999384							ADWR 2009b	
252	NWIS-2	364645111461301	3	A-39-06 17DAB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	Navajo Ss			36.77915315	-111.7709992	04-Aug-76	04-Aug-76	18	18	18	1	USGS 2010b	
253	BLM-Legacy	LEG-196	1	Lowrey Spring; A-40-07 30A		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.84013	-111.68136	01-Jul-85	01-Jul-85	3.5	3.5	3.5	1	BLM 2010d	Pipeline at Time of Spring Schedule Figures Pipeline Has Been Redone (12/85) / New Well (Horizontal) Pipe and Tanks (Private)
253	GWSI-1	365022111405201	2	Lowrey Spring; A-40-07 30ACA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring			Contact	36.839430781	-111.681829944							ADWR 2009b	
253	NWIS-2	365022111405201	3	A-40-07 30ACA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	Moenave Fm			36.8394312	-111.68183							USGS 2010b	
254	GCWC-02-Map	M-137	1	Unnamed (two Mile Spring); A-40-03 34DAA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.82347	-112.05596							Grand Canyon Wildlands Council 2002	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
254	NURE	GCAH502R	2			East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	TRSS Ss			36.822887742	-112.055332887							USGS 2009b	
255	GCWC-02-Map	M-142	1	Jacob Cliff; A-38-05 06AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.72858	-111.89771							Grand Canyon Wildlands Council 2002	
255	NURE	MCBA501R	2			East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	TRSS Ss			36.727387297	-111.898225449							USGS 2009b	
256	GCWC-02-Map	M-193		Twin Springs (Upper); A-40-06 35DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.81766	-111.72035							Grand Canyon Wildlands Council 2002	
257	GCWC-02-Map	M-138		Unnamed??; A-39-03 03DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.80317	-112.0597							Grand Canyon Wildlands Council 2002	
258	BLM-Legacy	LEG-133		One Mile Spring; A-39-03 03DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.80661	-112.05492	01-Jul-85	01-Jul-85	1.6	1.6	1.6	1	BLM 2010d	
259	BLM-Legacy	LEG-134		Deer Spring; A-39-03 11BB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.79864	-112.05336	01-Jul-85	01-Jul-85	0.25	0.25	0.25	1	BLM 2010d	Average Discharge = 0.0025 Gallons per Minute/ Deer Springs on Map Should Be House Rock Spring at this Location/ Deer Spring is Located: T39N, R3E, 10, Nene--Next Canyon North/Local
260	GCWC-02-Map	M-419		Four Springs; A-39-03 11DBB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.79398	-112.04602							Grand Canyon Wildlands Council 2002	
261	GCWC-02-Map	M-420		Four Springs; A-39-03 11DB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.79163	-112.04526							Grand Canyon Wildlands Council 2002	
262	GCWC-02-Map	M-421		Four Springs; A-39-03 11DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.78907	-112.04469							Grand Canyon Wildlands Council 2002	
263	GCWC-02-Map	M-422		Four Springs; A-39-03 14AB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.78628	-112.04473							Grand Canyon Wildlands Council 2002	
264	GCWC-02-Map	M-423		House Rock Spring; A-39-03 13CCB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.7762	-112.03588							Grand Canyon Wildlands Council 2002	
265	BLM-Legacy	LEG-141		Hancock Spring; A-39-05 31BA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.74193	-111.90403	01-Jul-85	01-Jul-85	2	2	2	1	BLM 2010d	a.K.a. Cottonwood/ Improved Spring With 7500' of 1 1/4 Pipe to Trough and Reservoir on Patented Land/2+ Gallons/Minute// Pipeline from Hancock Spring Down to Reservoir and Trough
266	BLM-Legacy	LEG-101		Sunset Spring; A-38-05 05CA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.71891	-111.88498							BLM 2010d	
267	BLM-Legacy	LEG-100		Emmett Spring; A-38-05 08A		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.71102	-111.87558	01-Jul-85	01-Jul-85	2	2	2	1	BLM 2010d	T37N,R5E,4,Nwne = Dor1 Year Round/ T38N, R5E, 36, Swse = Lst2 169 0301-0228/ T38N, R6E, 30, Swsw = Lst2 169 0301-0228/ T38N, R6E, 17, Nene=Lst2 169 0301-0228/ Jdr# Original Pipeline:4771 Ext 4
268	BLM-Legacy	LEG-96		Jacob Cliff Spring East; A-38-05 06AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.72747	-111.89573	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	
269	BLM-Legacy	LEG-97		Jacob Cliff Spring Main; A-38-05 06BA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.72842	-111.90332	01-Jul-85	01-Jul-85	1	1	1	1	BLM 2010d	Jdrs:1819 and 5006 Contain Pipeline Information for Jacobs Pools/Wet Area 6' × 10' × 325'
270	BLM-Legacy	LEG-98		Jacob Cliff Spring North; A-38-05 06BA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.72784	-111.90154	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	Wet Area: 8' × 60'

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Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
271	BLM-Legacy	LEG-155		Cottonwood Seeps; A-39-06 21CB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.7632	-111.7634	03-Jul-88	03-Jul-88	0.5	0.5	0.5	1	BLM 2010d	
272	BLM-Legacy	LEG-153		Netherland Seep; A-39-06 10DAA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.79262	-111.7314							BLM 2010d	
273	BLM-Legacy	LEG-144	1	Dutchman Spring; A-39-06 10DBD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.79225	-111.73646	02-Jul-88	02-Jul-88	0.7	0.7	0.7	1	BLM 2010d	
273	BLM-Legacy	LEG-150	2	Dutchman Seep; A-39-06 10DBD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.79225	-111.73646	01-Jul-85	01-Jul-85	0.2	0.2	0.2	1	BLM 2010d	Seep Flow 0.25 Gallons per Minute/100% Wildlife Use
274	BLM-Legacy	LEG-146		Short Seep; A-39-06 27BAA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75746	-111.7404							BLM 2010d	
275	BLM-Legacy	LEG-149		Halfmoon Seep; A-39-06 29CDB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75111	-111.77963	05-Jul-88	05-Jul-88	0.1	0.1	0.1	1	BLM 2010d	
276	BLM-Legacy	LEG-154		Walts Spring; A-39-06 30DBC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.74829	-111.79217	01-Jul-85	05-Jul-88	0.75	2	1.375	2	BLM 2010d	Deer Use/Flow Estimated at 0.75 Gallons per Minute on 07-05-88
277	GCWC-02-Map	M-84		Twin Springs (Middle); A-40-06 35DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.81677	-111.71878							Grand Canyon Wildlands Council 2002	
278	GCWC-02-Map	M-435		Twin Springs (Lower); A-39-06 02A		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.81485	-111.71786							Grand Canyon Wildlands Council 2002	
279	GCWC-02-Map	M-429		Badger Spring; A-39-06 01B		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.81506	-111.70883							Grand Canyon Wildlands Council 2002	
280	BLM-Legacy	LEG-61		Seven Mile Spring Upper; A-40-06 36ADD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.82431	-111.69641	01-Jul-85	01-Jul-85	0.6	0.6	0.6	1	BLM 2010d	
281	BLM-Legacy	LEG-190		Seven Mile Seep; A-40-06 36DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.82294	-111.69622							BLM 2010d	
282	BLM-Legacy	LEG-192		Seven Mile Spring Lower; A-40-06 36DD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.81825	-111.69554	01-Jul-85	01-Jul-85	0.1	0.1	0.1	1	BLM 2010d	
283	BLM-Legacy	LEG-197		Seven Mile Seep; A-40-07 31CC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.81811	-111.69122							BLM 2010d	
284	BLM-Legacy	LEG-148		Smokey Spring; A-39-06 19DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.76438	-111.78562	01-Jul-85	04-Jul-88	2	10	6	2	BLM 2010d	Flow Was 1.0 Gallons per Minute on 07-04-88
285	BLM-Legacy	LEG-147		Soap Spring; A-39-06 17AD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.7769	-111.76972	08-Aug-85	08-Aug-85	6.3	6.3	6.3	1	BLM 2010d	T39N,R6E,26,Nwse = Location of Trough
286	BLM-Legacy	LEG-102		Soap Creek Seep; A-38-05 02DB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.71995	-111.82555							BLM 2010d	Seep Exists High in Cliff/No Access to Source/No Flow Rate or Tds/Ec Report
287	BLM-Legacy	LEG-132		908 Spring; A-39-03 25AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75541	-112.02146	01-Jul-85	01-Jul-85	0	0	0	1	BLM 2010d	Spring is Dry/Subject to Flash Flood
288	BLM-Legacy	LEG-139		Banal Spring; A-39-04 27AB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75775	-111.95535	07-Aug-85	07-Aug-85	0.8	0.8	0.8	1	BLM 2010d	Reported Section Was 22,Should Be 27 Listed in Amp File(House Rock)/No Jdr File Listed But Possible File #'S per Case File/ Schoppman,Melvin,Orjohn Are As Follows:1678,1402,7
289	BLM-Legacy	LEG-160		Combination Seeps; A-39-06 20C		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.76231	-111.78256	04-Jul-88	04-Jul-88	0.7	0.7	0.7	1	BLM 2010d	
290	BLM-Legacy	LEG-161		Cottonwood Spring Upper; A-39-06 21CB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.76314	-111.76501	05-Jul-88	05-Jul-88	2.4	2.4	2.4	1	BLM 2010d	
291	BLM-Legacy	LEG-162		Cottonwood Spring Lower; A-39-06 21CB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.76177	-111.76333	08-Aug-85	08-Aug-85	1.4	1.4	1.4	1	BLM 2010d	Location of Cottonwood Spring(Seep)Located on Emmett Wash 15'is in Wrong Location,Instead of T39N,R6E,32,Swnw,Should Read T39N,R6E,29,Swnw on Paria Plateau Se 7.5' Map/No Li
292	BLM-Legacy	LEG-164		Early Seep; A-39-06 01CC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.80379	-111.71043	01-Jul-88	01-Jul-88	0.1	0.1	0.1	1	BLM 2010d	
293	BLM-Legacy	LEG-156		Eyewhere Seep; A-39-06 29DB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.74991	-111.77813	05-Jul-88	05-Jul-88	0.1	0.1	0.1	1	BLM 2010d	

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Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
294	BLM-Legacy	LEG-194	1	Fisher Springs Upper; A-40-07 16ADC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.86856	-111.6454	01-Jul-85	01-Jul-85	1.5	1.5	1.5	1	BLM 2010d	Single Pipeline from Fisher Down Canyon to Natural Rock Pool in Same Section
294	BLM-Legacy	LEG-195	2	Fisher Springs Lower; A-40-07 16AD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.86856	-111.6454	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	Two Springs Located at Fisher Spring/Upper Spring with Pipeline
295	BLM-Legacy	LEG-135		Hod Brown Seep West; A-39-03 13BC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.78122	-112.03468	01-Jul-85	01-Jul-85	0.2	0.2	0.2	1	BLM 2010d	
296	BLM-Legacy	LEG-136		Hod Brown Seep East; A-39-03 13BC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.78122	-112.03468	01-Jul-85	01-Jul-85	0.3	0.3	0.3	1	BLM 2010d	
297	BLM-Legacy	LEG-137		Hod Brown Spring; A-39-03 13BC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.78122	-112.03468	01-Apr-81	01-Apr-81	0.2	0.2	0.2	1	BLM 2010d	12' Tunnel with Collection Box (Which is Trash Can Lid)/ Poor Condition,Pipe Broken/Pipeline Shown on Folks's Wilderness Map/ Local Name:Hod Brown
298	BLM-Legacy	LEG-158		Ima Spring; A-39-06 20DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75959	-111.773	04-Jul-88	04-Jul-88	0.9	0.9	0.9	1	BLM 2010d	
299	BLM-Legacy	LEG-159		Ima Seep; A-39-06 20DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75959	-111.773	04-Jul-88	04-Jul-88	0.1	0.1	0.1	1	BLM 2010d	
300	BLM-Legacy	LEG-157		Laurita Spring; A-39-06 19DD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.76062	-111.78666	04-Jul-88	04-Jul-88	1	1	1	1	BLM 2010d	
301	BLM-Legacy	LEG-143		Lightening Spring; A-39-06 20AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.77185	-111.76825	03-Jul-88	03-Jul-88	1.9	1.9	1.9	1	BLM 2010d	
302	BLM-Legacy	LEG-163		Old Juniper Spring; A-39-06 20CD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.76125	-111.77727	04-Jul-88	04-Jul-88	1.2	1.2	1.2	1	BLM 2010d	
303	BLM-Legacy	LEG-152		Lower Badger Spring; A-39-06 01D		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.80668	-111.69898	01-Jul-85	01-Jul-85	5	5	5	1	BLM 2010d	Domestic Use st Vermilion Cliff Lodge/Three Culinary Tanks: One Steel and Two Were Rock Tanks/Average Discharge Spring >5.0 Gallons per Minute
304	BLM-Legacy	LEG-140		Parker Spring; A-39-04 30BD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75302	-112.01142							BLM 2010d	No Flow Could be Measured/Parker Spring is a Deep Cistern 9' Deep, 2' Wide
305	BLM-Legacy	LEG-189		Unknown Private Spring; A-40-03 34DD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.81862	-112.0572	01-Jul-85	01-Jul-85	2	2	2	1	BLM 2010d	
306	BLM-Legacy	LEG-151		A-39-06 29B (seep)		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.75517	-111.78076	08-Aug-85	08-Aug-85	0	0	0	1	BLM 2010d	No Flow at Spring Source/ Damp Soil only 08-08-85/ Spring Re-Emerges Below
307	NHD-1	126015281				East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring				36.7626388763	-111.966644803							USGS 2007	
321	GCWC-02-Map	M-366	1	Kane Spring; A-37-03 23CD		East Buffer	Kaibab Plateau	Perched	Spring				36.58589	-112.04517							Grand Canyon Wildlands Council 2002	
321	NURE	GCBH501R	2			East Buffer	Kaibab Plateau	Perched	Spring	UNKN Ss			36.585686378	-112.04532917							USGS 2009b	
322	GCWC-02-Map	M-171		Tater Canyon Spring; A-36-03 27BB		East Buffer	Kaibab Plateau	Perched	Spring				36.49573	-112.07151							Grand Canyon Wildlands Council 2002	
323	GCWC-02-Map	M-418		Burro Spring; A-40-03 32DD		East Buffer	Kaibab Plateau	Perched	Spring				36.81823	-112.09448							Grand Canyon Wildlands Council 2002	
324	GCWC-02-Map	M-434		Aho; A-39-06 30		East Buffer	Kaibab Plateau	Perched	Spring				36.75249	-112.12127							Grand Canyon Wildlands Council 2002	
325	NPS_All_Hydro	TW-1				East Buffer	Marble Canyon	Perched	Spring				36.6993301931	-111.71162556							Grand Canyon National Park 2010b	
326	SIR-2010-5025	363907111471701	1	Rider Spring; A-38-06 31		East Buffer	Marble Platform	Perched	Spring				36.651944	-111.788056	25-Aug-09	25-Aug-09	0.02	0.02	0.02	1	Bills et al. 2010	East Segregation/House Rock Springs - House Rock Area, No Uranium Mines, Breccia Pipes Present
326	NWIS-1	363907111471701	2	Rider Spring		East Buffer	Marble Platform	Perched	Spring				36.65194444	-111.78805556							USGS 2009a	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
326	GCWC-02-Map	M-399	3	Rider Spring; A-38-06 31AA		East Buffer	Marble Platform	Perched	Spring				36.65293	-111.78748							Grand Canyon Wildlands Council 2002	
327	SIR-2010-5025	362856111542301		South Canyon Spring; A-36-05 31		East Buffer	Marble Platform	Perched	Spring				36.482222	-111.906389							Bills et al. 2010	East Segregation/House Rock Springs - House Rock Area, No Uranium Mines, Breccia Pipes Present
328	GCWC-02-Map	M-338		A-36-04 36 (seep)		East Buffer	Marble Platform	Perched	Spring				36.47598	-111.92185							Grand Canyon Wildlands Council 2002	No Spring on Topo
331	GWSI-1	362957111512601	1	Vasey's Paradise Spring; A-36-05 27B		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls	Perennial	Tubular Cave	36.499153222	-111.857943296	08-Aug-23	14-Jun-60	67.2	4480	1786.4	4	ADWR 2009b	
331	NWIS-2	362957111512600	2	N14 Vasey's Paradise, River Mile 31.9	31.9	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.49915289	-111.8579435	29-Apr-76	20-Nov-81	500	2244.156	1372.078	2	USGS 2010b	
331	GCNP-1	COLO029	3	Vasey's Paradise at pool		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.497726632	-111.857826815	09-May-04	13-Oct-07	298	3949.1	1377.525	4	Grand Canyon National Park 2010a	
331	SIR-2010-5025	362957111512601	4	Vasey's Paradise Spring; A-36-05 27B UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.499167	-111.857222	21-Aug-09	21-Aug-09	260	260	260	1	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of the Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
331	NWIS-2	362957111512601	5	A-36-05 27B UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.49915289	-111.8579435	20-Jun-65	20-Jun-65	1792	1792	1792	1	USGS 2010b	
331	ONWI-85	Spr10	6	River Mile 31.8; West bank; Vasey's Paradise Spring	31.8W	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.499167	-111.857222	19-Sep-82	19-Sep-82	2000	2000	2000	1	Woodward-Clyde Consultants 1985	
331	Peterson-77	CF-1	7	Vasey's Paradise, River Mile 31.9	31.9	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.499152922	-111.857943496							Peterson et al. 1977	
331	GCWC-02	GCNP-102	8	Vaseys Paradise; A-36-05 27B		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls	Perennial	Contact; Fracture	36.5017	-111.85945	26-Mar-01	26-Mar-01	838	838	838	1	Grand Canyon Wildlands Council 2002	Colorado River in Grand Canyon Mile 31.9, at Rivers Edge North Side
332	GWSI-1	362837111504201	1	Hanging Spring; A-36-05 34A		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.476930209	-111.845720434							ADWR 2009b	
332	NWIS-2	362837111504201	2	Redwall Spring at River Mile 34.2; A-36-05 34A UNSURVEYED	34.2	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.47693065	-111.8457204							USGS 2010b	
332	SIR-2010-5025	362837111504201	3	Hanging Spring; A-36-05 34A UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring				36.476944	-111.845							Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of the Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
332	Peterson-77	CF-3	4	River Mile 34.2	34.2	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls			36.476930609	-111.845720434	29-Apr-76	29-Apr-76	15	15	15	1	Peterson et al. 1977	
333	SIR-2010-5025	363123111503101	1	A-36-05 14; Fence Spring		East Buffer	Marble Canyon	Regional	Spring				36.523056	-111.841944	20-Aug-09	20-Aug-09	732	732	732	1	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of the Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
333	NWIS-1	363123111503101	2	Fence Spring		East Buffer	Marble Canyon	Regional	Spring				36.52305556	-111.84194444							USGS 2009a	
334	SIR-2010-5025	362831111504401	1	Hole in the Wall Spring; A-36-05 34DBA UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring				36.475278	-111.845556	22-Aug-09	22-Aug-09	8.8	8.8	8.8	1	Bills et al. 2010	
334	NWIS-1	362831111504401	2	Hole-in-the-Wall Spring		East Buffer	Marble Canyon	Regional	Spring				36.47526398	-111.84627599							USGS 2009a	
335	GCWC-02-Map	M-38	1	Hanging Springs; A-36-05 34		East Buffer	Marble Canyon	Regional	Spring				36.47378	-111.84561							Grand Canyon Wildlands Council 2002	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
335	SIR-2010-5025	362827111504101	2	Unknown Spring; A-36-05 34		East Buffer	Marble Canyon	Regional	Spring				36.474167	-111.844722	21-Aug-09	21-Aug-09	0.68	0.68	0.68	1	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of the Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
335	NWIS-1	362827111504101	3			East Buffer	Marble Canyon	Regional	Spring				36.47416667	-111.84472222							USGS 2009a	
336	ONWI-85	Spr01		River Mile 25.3; East bank	25.3 E	East Buffer	Marble Canyon	Regional	Spring				36.5756989548	-111.794093644	19-Sep-82	19-Sep-82	5	5	5	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints along the Colorado River; Samples Considered Representative of in Situ Con
337	GCNP-1	COLO027	1	Fence Fault River Left		East Buffer	Marble Canyon	Regional	Spring				36.51885	-111.8458917							Grand Canyon National Park 2010a	
337	ONWI-85	Spr02	2	River Mile 30.5; East bank	30.5 E	East Buffer	Marble Canyon	Regional	Spring				36.5193755158	-111.845560267	19-Sep-82	19-Sep-82	17	17	17	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints Along the Colorado River; Samples Considered Representative of in Situ Con
338	ONWI-85	Spr03		River Mile 30.6: East bank	30.6 E	East Buffer	Marble Canyon	Regional	Spring				36.5179057511	-111.845830322	19-Sep-82	19-Sep-82	1500	1500	1500	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints Along the Colorado River; Samples Considered Representative of in Situ Con
339	GCNP-1	COLO026	1	Fence Fault River Right		East Buffer	Marble Canyon	Regional	Spring				36.5155167	-111.8479639							Grand Canyon National Park 2010a	
339	ONWI-85	Spr04	2	River Mile 30.8; West bank	30.8W	East Buffer	Marble Canyon	Regional	Spring				36.5153410469	-111.847892133	19-Sep-82	19-Sep-82	1000	1000	1000	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints Along the Colorado River; Samples Considered Representative of in Situ Con
340	ONWI-85	Spr05		River Mile 30.7; West bank	30.7W	East Buffer	Marble Canyon	Regional	Spring				36.5168034074	-111.847410344	19-Sep-82	19-Sep-82	35	35	35	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints Along the Colorado River; Samples Considered Representative of in Situ Con

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
341	ONWI-85	Spr06		River Mile 30.7; East bank; Marble Platform end member	30.7E	East Buffer	Marble Canyon	Regional	Spring				36.5164682212	-111.846115093	19-Sep-82	19-Sep-82	150	150	150	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints Along the Colorado River; Samples Considered Representative of in Situ Con
342	ONWI-85	Spr07		River Mile 35.0; West bank	35.0W	East Buffer	Marble Canyon	Regional	Spring				36.4701527469	-111.841452938	19-Sep-82	19-Sep-82	5	5	5	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints Along the Colorado River; Samples Considered Representative of in Situ Con
343	ONWI-85	Spr09		River Mile 31.2; West bank; Kaibab Plateau end member	31.2W	East Buffer	Marble Canyon	Regional	Spring				36.5102826648	-111.850994644	19-Sep-82	19-Sep-82	250	250	250	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on/near Fault Zones, Fractures, or Joints Along the Colorado River; Samples Considered Representative of in Situ Con
344	GCNP-1	COLO045		Monkey Flower Spring	34R	East Buffer	Marble Canyon	Regional	Spring				36.4727778	-111.843611							Grand Canyon National Park 2010a	
345	GCWC-02	GCNP-101		Fence Fault north; A-36-05 15A		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls	Perennial	Contact; Fracture	36.52575	-111.84546	26-Mar-01	26-Mar-01	300	300	300	1	Grand Canyon Wildlands Council 2002	Colorado River in Grand Canyon Mile 30.3, at Rivers Edge Right North (Side)
346	NHD-1	126014479				East Buffer	Marble Canyon	Regional	Spring				36.52921581	-111.833306404							USGS 2007	
347	NWIS-2	363114111504200		South Canyon Springs at River Mile 31.5	31.5	East Buffer	Marble Canyon	N/A	Stream				36.5205419	-111.845721							USGS 2010b	
352	USFS-10	Miller_Seep		Miller Seep; A-29-03 21		South	Coconino Plateau - East	Perched	Spring				35.8867770776	-112.06806107							Hannemann 2010	Location from USGS 2007
364	NHD-1	124578793				South Buffer	Coconino Plateau - East	Perched	Spring				35.7226250112	-111.82869527							USGS 2007	
365	NWIS-2	360952112203501		A-32-01 13 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Perched	Spring				36.16442575	-112.3437879							USGS 2010b	
366	NWIS-2	360711112184601		A-32-01 32 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Perched	Spring				36.11970404	-112.3135086							USGS 2010b	
367	STORET-1	GRCA_FIT_ EREM02	1	Dripping Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Hermit Sh - Coconino Ss			36.063333	-112.243167							USEPA 2010	Dripping Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Upper Reaches of the Hermit Creek Drainage. Dripping Springs Flows from the Outcrop at the Hermit Shale-Coconino Sandstone, the Spring Orifice Faces South
367	GCNP-1	EREM002	2	Dripping Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Coconino/ Hermit Contact			36.062679383	-112.24263762							Grand Canyon National Park 2010a	
367	Fitz-96	DRIP	3	Dripping Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Hermit Sh - Coconino Ss	Perennial	Contact	36.06633	-112.24633	17-Mar-95	22-Jul-95	1	1	1	1	Fitzgerald 1996	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
368	STORET-1	GRCA_FIT_ HERM08	1	Santa Maria Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Esplanade Ss			36.06	-112.221944							USEPA 2010	Santa Maria Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Upper Reaches of the Hermit Creek Drainage. Santa Maria Spring Issues from Sandstone Beds in the Esplanade Formation, There Are No Associated Structure
368	GCNP-1	HERM008	2	Santa Maria Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Supai Fm			36.0600715	-112.221833981							Grand Canyon National Park 2010a	
368	Fitz-96	SANMA	3	Santa Maria Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Esplanade Ss	Perennial	Bedding Planes	36.0595	-112.219833	17-Mar-95	22-Jul-95	0.5	0.5	0.5	1	Fitzgerald 1996	
369	STORET-1	GRCA_FIT_ KOLB02	1	Kolb Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring				36.0577778	-112.1427778							USEPA 2010	Kolb Spring is Located on the South Rim Within the Boundary of Grand Canyon National Park near Grand Canyon Village at the Start of the Bright Angel Trail.
369	Fitz-96	KOLB	2	Kolb Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Coconino Ss	Intermittent		36.0577778	-112.1427778	01-Jan-94	01-Jan-94	0.5	0.5	0.5	1	Fitzgerald 1996	
370	NHD-1	GNIS-00011060		Seep Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring				36.1817504772	-112.400786603							USGS 2007	
371	NPS_All_Hydro	HP-22e				South Buffer	Grand Canyon - South Rim	Perched	Spring				36.1374712589	-112.317514206							Grand Canyon National Park 2010b	
372	NPS_All_Hydro	HP-24b				South Buffer	Grand Canyon - South Rim	Perched	Spring				36.1076409205	-112.316095119							Grand Canyon National Park 2010b	
373	NPS_All_Hydro	HP-25c				South Buffer	Grand Canyon - South Rim	Perched	Spring				36.1282070205	-112.280171629							Grand Canyon National Park 2010b	
374	NPS_All_Hydro	HP-65c				South Buffer	Grand Canyon - South Rim	Perched	Spring				36.1611757721	-112.458300348							Grand Canyon National Park 2010b	
375	NPS_All_Hydro	VT-16				South Buffer	Grand Canyon - South Rim	Perched	Spring				36.0546277371	-111.819209678							Grand Canyon National Park 2010b	
387	STORET-1	GRCA_GS2_ GRAP07	1	Grapevine Main Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0110909	-112.0033028							USEPA 2010	Grapevine Main Spring is in a Small Canyon that is Tributary to the Main Southeast Trending Canyon of Grapevine Creek About 3 Km Upstream from the Tonto Trail. Water Discharges from Bedding Planes at Several Places in the Upper Part of the Muav Limestone
387	Monroe-05	360232112004802	2	Grapevine Main Spring; upper Bright Angel near Muav contact (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.0092664923	-112.002557176							Monroe et al. 2005	
387	NWIS-2	360040112000901	3	A-30-04 01 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.011111	-112.0025	15-Nov-01	15-Nov-01	0	0	0	1	USGS 2010b	Coordinates Based on Site ID
388	NWIS-2	360059111581700	1	VT9 Miners Spring at Trail in Hance Canyon		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.01637288	-111.972108	20-Nov-81	20-Nov-81	0.1	0.1	0.1	1	USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
388	STORET-1	GRCA_FIT_ PAGE02	2	Page Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls - Bright Angel Sh		Contact	36.016167	-111.973							USEPA 2010	Page Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Upper Reaches of the Hance Creek Drainage. the Spring Discharges from the Muav Limestone-Bright Angel Shale Contact and Flow Was Constant Throughout the Durat
388	Fitz-96	PAGE	3	Page Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent	Contact; Fold axis	36.0161667	-111.973	08-Jan-94	09-Sep-95	1.5	1.5	1.5	1	Fitzgerald 1996	
388	NWIS-2	360100111582001	4	A-30-04 04 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall Ls			36.01665064	-111.9729413	24-May-00	06-Jun-02	0	0	0	2	USGS 2010b	
388	Monroe-05	360100111582001	5	Miners Spring; upper Bright Angel near Muav contact (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls			36.0146513792	-111.971428242							Monroe et al. 2005	
389	STORET-1	GRCA_GS2_ HANC03	1	Hance Creek Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0000694	-111.9525							USEPA 2010	the Spring Emerges from a Wall in a Southwest Facing Alcove, in East Arm at the Source of Hance Creek. Samples Were Collected Five Meters Down the Drainage from the Wall. Discharge Was Determined at a Bright Angel Formation Ledge near the Spring. the Sit
389	Monroe-05	360025111571501	2	JT Spring (Hance Spring; upper Bright Angel near Muav contact (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls			36.0024888923	-111.951010589							Monroe et al. 2005	
389	NWIS-2	360025111571501	3	A-30-04 10 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.00692874	-111.9548848							USGS 2010b	
390	NWIS-2	360020111560401	1	Red Canyon Spring; A-30-04 11 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.00554019	-111.9351617							USGS 2010b	
390	Monroe-05	360020111560401	2	Red Canyon Spring; upper Bright Angel near Muav contact (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls			36.003934951	-111.934451814	26-Sep-01	26-Sep-01	4.488312	4.488312	4.488312	1	Monroe et al. 2005	
391	STORET-1	GRCA_GS2_ BOUC07	1	Boucher Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0897709	-112.2603246							USEPA 2010	Boucher Spring is Located in the Main Drainage of Boucher Creek. the Spring Discharges from the Contact Between the Redwall Limestone and Muav Limestone. Additional Seeps Exist Below the Spring on Both Sides of the Channel. the Site is Located Within the
391	NWIS-2	360511112155501	2	A-31-01 10 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.086371	-112.2660067	25-Apr-02	25-Apr-02	0	0	0	1	USGS 2010b	
392	STORET-1	GRCA_FIT_ GARD05	1	Two Trees Spring (Pumphouse Spring)		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0775307	-112.1261403							USEPA 2010	Two Trees Spring (Also Known As Pumphouse Spring and Indian Garden Spa) is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Garden Creek Drainage. Samples Were Collected from Below Two Trees on Eastern Canyon Wall. the Dis
392	GCNP-1	GARD005	2	Two Tree Spring at Spring Box		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0775307	-112.1261403							Grand Canyon National Park 2010a	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
392	NWIS-2	360441112073201	3	A-31-02 13 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.07803835	-112.1262803	22-May-00	19-Nov-01	0	0	0	1	USGS 2010b	
392	Monroe-05	360441112073201	4	Pumphouse Spring; mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Alluvium			36.0757061384	-112.125390342							Monroe et al. 2005	
392	Fitz-96	TWOTREE	5	Two Tree Springs in Indian Garden basin		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault	36.0781667	-112.125667	30-Apr-94	26-Nov-95	221	221	221	1	Fitzgerald 1996	
393	GCNP-1	SALT004	1	Salt creek at Source		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav LS			36.0768635	-112.161769							Grand Canyon National Park 2010a	
393	Monroe-05	360439112094101	2	Salt Creek Spring; upper Bright Angel (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.0750407332	-112.161016483	23-May-00	10-Apr-01	0	0	0	1	Monroe et al. 2005	
393	NWIS-2	360439112094101	3	A-31-02 15 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.0774826	-112.1621147							USGS 2010b	
394	NWIS-2	360347112133001		A-31-02 18 2 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0713713	-112.2193385	11-Apr-01	19-Nov-01	179.53248	179.53248	179.53248	1	USGS 2010b	
395	NWIS-2	360400112025001	1	A-31-03 14 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.06664989	-112.0479446							USGS 2010b	
395	Monroe-05	360400112025001	2	LoneTree Spring; upper Bright Angel near Muav contact (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.0647634503	-112.047253581							Monroe et al. 2005	
396	STORET-1	GRCA_FIT_ GRAP03	1	Grapevine East Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.0422846	-112.012395							USEPA 2010	Grapevine East Springs Are Located in the South Rim Within the Boundary of Grand Canyon National Park in the Grapevine Creek Drainage, at the Tonto Trail. Discharge from the Bright Angel Shale is Constant and Heavy Vegetation Growth Occurs Around the Spri
396	Fitz-96	GRAP-E	2	Grapevine East Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh	Intermittent	Fold axis	36.042833	-112.0135	12-Nov-94	17-Jul-95	2	2	2	1	Fitzgerald 1996	
396	Monroe-05	360232112004801	3	Grapevine East Spring; lower Bright Angel (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.0404607299	-112.011647689	25-May-00	09-Apr-01	0	0	0	1	Monroe et al. 2005	
396	NWIS-2	360232112004801	4	Grapevine East Spring; A-31-03 25 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.04220565	-112.0140544	12-Dec-00	14-Nov-01	0	0	0	1	USGS 2010b	
396	GCNP-1	GRAP003	5	Grapevine East spring at Tonto Trail		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.042513652	-112.013652492	14-Dec-04	05-Nov-08	0	6.42	1.7891412208	7	Grand Canyon National Park 2010a	
397	NWIS-2	360108111592600		A-31-04 32		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.02442815	-111.9882199							USGS 2010b	
398	NWIS-2	360128111591200		A-31-04 32 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.02444	-111.98667	25-May-00	25-May-00	0	0	0	1	USGS 2010b	Coordinates Assigned from Site ID
399	NWIS-2	361141112211101		A-32-01 02 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.19470315	-112.3537885	21-Apr-02	21-Apr-02	0	0	0	1	USGS 2010b	
400	NWIS-2	360814112195100		A-32-01 19 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.13803717	-112.330176	22-Apr-02	22-Apr-02	0	0	0	1	USGS 2010b	
401	NWIS-2	360121111591900		Cottonwood 4 at Cottonwood Creek near Grand Canyon		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.02248369	-111.989331							USGS 2010b	
402	STORET-1	GRCA_FIT_ PIPE04	1	Pipe Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls		Contact	36.0718389	-112.1023579							USEPA 2010	Pipe Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Pipe Creek Drainage. Discharge from the Bright Angel Shale-Muav Limestone Contact Fluctuates, With Higher Flow Occurring March Through May. Samples Were Colle

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
402	Liebe-03	P-UP	2	Pipe Spring; sampled at first visible water bearing spot at small nearby creek east of Bright Angel Fault		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls Contact			36.071667	-112.101667							Liebe 2003	Sampled at First Visible Water Bearing Point of Small Nearby Creek East of Bright Angel Fault; Issue Probably at Redwall-Muav Limestone Contact; Elevation 3964 Feet Above Mean Sea Level; Discharge at Pipe Spring 0.92 Gpm According to Personal Communicatio
402	Liebe-03	P-DOWN	3	Pipe Spring; sampled approximately 165' downstream from Pipe Up		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls Contact			36.07207	-112.10182	04-Jun-02	29-Jul-02	0.92	0.92	0.92	1	Liebe 2003	Sampled Approximately 165 Feet Downstream from the Pipe Stream (Pipe Up) Sample Site; Discharge at Pipe Spring 0.92 Gpm According to Personal Communication Between Liebe and R.D. Foust in October of 2002
402	NWIS-2	360410112055700	4	A-31-03 18 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.07081629	-112.1023907	22-May-00	08-Apr-01	4.488312	4.488312	4.488312	1	USGS 2010b	
402	Fitz-96	PIPE	5	Pipe Creek / Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault	36.070667	-112.0981667	11-Jan-94	19-Jul-95	104	104	104	1	Fitzgerald 1996	
403	Liebe-03	H-UP	1	Horn Creek at base of Redwall-Muav Limestone contact		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls Contact			36.07802	-112.14559							Liebe 2003	Sample Taken Right at Issue of Horn Creek at the Base of the Redwall-Muav Limestone Contact; Elevation 4074 Feet Above Mean Sea Level
403	Liebe-03	H-DOWN	2	Horn Creek approximately 100' downstream from Horn Up		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls			36.07827	-112.14521							Liebe 2003	Sample Taken Approximately 100 Feet Downstream from Horn Up Sampling Location
404	GCNP-1	PIPE005	1	Burro Spring Source		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.076637548	-112.100341433							Grand Canyon National Park 2010a	
404	STORET-1	GRCA_FIT_ PIPE03	2	Burro Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Contact	36.0766445	-112.1010173							USEPA 2010	Burro Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Pipe Creek Drainage, at the Tonto Trail. the Spring Discharges from the Bright Angel Shale-Muav Limestone Contact and Flow is Constant on An Annual Basis. Ab
404	Fitz-96	BURR	3	Burro Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault	36.076671	-112.101	29-Apr-94	19-Jul-95	4	4	4	1	Fitzgerald 1996	
404	NWIS-2	360437112060210	4	BA24 Burro Spring at Tonto Trail		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.07692737	-112.1012796	01-Sep-81	01-Sep-81	8.976624	8.976624	8.976624	1	USGS 2010b	
404	Liebe-03	B-DOWN	5	Burro Spring; sampled approximately 150' downstream of Burro Up		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.07662	-112.10024	04-Jun-02	15-Jul-02	4.94	4.94	4.94	1	Liebe 2003	Sampled Approximately 150 Feet Below the Burro Spring (B-Up) Sampling Site;
404	Liebe-03	B-UP	6	Burro Spring; 0.6 miles east of Pipe Spring on Tonto hiking Trail		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.076667	-112.099722							Liebe 2003	Sample Site Located 0.6 Miles East of Pipe Spring on the Tonto Hiking Trail; Spring Discharge is 4.94 Gpm According to Personal Communication Between Liebe and R.D. Foust in October of 2002; Sampled at First Visible Water Bearing Point

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
405	Liebe-03	H-WEST		Horn West Sp; small dripping spring sampled directly at issue at Redwall-Muav Limestone contact		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls contact			36.08029	-112.15057							Liebe 2003	Most Westward Sample of Lieve'S Research Program, Horn West is a Small Dripping Spring Sampled Directly at Issue at the Redwall-Muav Limestone Contact; Elevation 4061 Feet Above Mean Sea Level
406	NWIS-2	09402450	1	Cottonwood Spring above the Confluence with Cotton		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0235948	-111.9882199	28-Sep-94	13-Jan-03	0	10.3231176	3.6063980632	57	USGS 2010b	
406	NWIS-2	360057111593101	2	Cottonwood Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.01581697	-111.9926644							USGS 2010b	
406	STORET-1	GRCA_FIT_ COTT04	3	Cottonwood Creek at USGS Gaging Station		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0235306	-111.9882389							USEPA 2010	Cottonwood Creek is Located in the South Rim Within the Boundary of Grand Canyon National Park. Samples Were Collected and Measurements Were Made at the Usgs Stream Gage (Station Number 09402450). Abundant Riparian Vegetation and Plant Waste Are Present I
406	GCNP-1	COTT004	4	Cottonwood Creek at Gage		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0235306	-111.9882389	14-Dec-04	14-Jan-09	0	7.46	2.1252386122	19	Grand Canyon National Park 2010a	
406	Monroe-05	360128111591502	5	Cottonwood Creek No. 2 (Cottonwood Spring); mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Alluvium			36.0170585342	-111.990420019							Monroe et al. 2005	
406	Fitz-96	COTT	6	Cottonwood Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault	36.021667	-111.98833	11-Nov-94	16-Jul-95	4.9371432	5.4	5.1685716	2	Fitzgerald 1996	
407	Fitz-96	HORN	1	Horn Creek / Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent		36.08462	-112.14128	30-Apr-94	26-Nov-95	0.5	0.5	0.5	1	Fitzgerald 1996	
407	STORET-1	GRCA_FIT_ HORN03	2	Horn Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.085833	-112.144333							USEPA 2010	Horn Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Horn Creek Drainage. Samples Collected from the Inner-Basin Sediment. at High Flow Regimes Samples Were Collected About 3/4 Mile Up the Drainage from the Tont
407	NWIS-2	360443112083300	3	A-31-02 11 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.08053824	-112.1440587	22-May-00	22-Nov-02	0	0	0	2	USGS 2010b	
408	STORET-1	GRCA_FIT_ GRAP09	1	Grapevine Hell Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring		Intermittent		36.04115	-112.0229417							USEPA 2010	Grapevine 'Hell' Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Grapevine Creek Drainage. the Spring is Dry the Majority of the Time and Abundant Salt Precipitate Occurs Around the Orifice. Grapevine 'Hell' Spr
408	Fitz-96	GRAP-HELL	2	Grapevine Hell Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh	Intermittent		36.04115	-112.022942							Fitzgerald 1996	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
409	STORET-1	GRCA_FIT_ HERM05	1	Hawaii Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls	Perennial		36.0706411	-112.2190538							USEPA 2010	Hawaii Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Hermit Creek Drainage. the Spring Discharges from the Muav Limestone and Flow Was Constant Throughout Duration of Investigation.
409	Fitz-96	HAWA	2	Hawaii Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls	Perennial	Fault	36.071667	-112.217667	18-Mar-95	25-Nov-95	3	3	3	1	Fitzgerald 1996	
409	Monroe-05	360417112130701	3	Hawaii Spring; mid Bright Angel (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh			36.068819616	-112.218300795	25-May-00	11-Apr-01	359.06496	359.06496	359.06496	1	Monroe et al. 2005	
409	NWIS-2	360417112130701	4	A-31-02 18 1 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.0713713	-112.2193385							USGS 2010b	
410	STORET-1	GRCA_FIT_ GRAP08	1	Grapevine Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls		Contact	36.023167	-112.013167							USEPA 2010	Grapevine Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Upper Reaches of the Grapevine Creek Drainage, 1 to 3 Miles Above the Tonto Trail. the Spring Discharges from the Bright Angel Shale-Muav Limestone Conta
410	Fitz-96	GRAP	2	Grapevine Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault	36.0231667	-112.0131667	12-Nov-94	17-Jul-95	5	5	5	1	Fitzgerald 1996	
411	STORET-1	GRCA_FIT_ CREM02	1	Sam Magee Spring (Cremation East)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls			36.0774974	-112.0631939							USEPA 2010	Sam Macgee Spring (Aka Cremation Creek East Spring) is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Eastern Cremation Creek Drainage. the Spring Discharges at a Very Low Rate from the Bright Angel Shale-Muav Limestone
411	GCNP-1	CREM002	2	Cremation far east spring, 'Sam Macgee'		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.077464648	-112.06307739	16-Dec-05	27-Feb-08	0	3.69	1.3016666667	3	Grand Canyon National Park 2010a	
411	Fitz-96	SAMM	3	Sam Magee Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent	Contact; Fold axis	36.078833	-112.065	10-Jan-94	19-Jul-95	0.25	0.25	0.25	1	Fitzgerald 1996	
411	NWIS-2	360442112034710	4	BA23 Cremation Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.07831644	-112.0637786							USGS 2010b	
412	STORET-1	GRCA_FIT_ HERM09	1	Hermit Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Temple Butte Ls			36.0645	-112.225167							USEPA 2010	Hermit Source Spring Hawaii Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Hermit Creek Drainage. Hermit Creek Drainage. Initial Discharge Occurs from the Temple Butte Limestone With No Significant Stream Flow
412	Fitz-96	HERM	2	Hermit Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall Ls	Perennial	Fault	36.0645	-112.225167	21-Jul-95	21-Jul-95	314	314	314	1	Fitzgerald 1996	
412	Monroe-05	360417112130702	3	Hermit Spring; lower Muav near Bright Angel contact (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls		Contact	36.0613648137	-112.224899832							Monroe et al. 2005	
412	NWIS-1	360336112131801	4	Hermit Spring; A-31-02 19 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.06008333	-112.22169444							USGS 2009a	
413	GCNP-1	MONU003	1	Monument Creek at source spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav LS/BA Sh			36.0656137	-112.1763915							Grand Canyon National Park 2010a	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
413	Monroe-05	360455112111002	2	Monument Spring; lower Muav near Bright Angel contact (bedRock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls		Contact	36.063789907	-112.175640307							Monroe et al. 2005	
413	NWIS-2	360356112103201	3	A-31-02 16 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0819269	-112.1868377	19-Nov-01	19-Nov-01	44.88312	44.88312	44.88312	1	USGS 2010b	
414	STORET-1	GRCA_GS2_ TURQ03		Turquoise Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1264131	-112.3385656							USEPA 2010	Turquoise Spring Emerges from the Upper Muav Limestone near the Confluence of the Three Upper Branches of Turquoise Creek. the Site is Within the Boundary of Grand Canyon National Park.
415	NPS_All_Hydro	BA-3k				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0994683606	-112.247231931							Grand Canyon National Park 2010b	
416	NPS_All_Hydro	BA-7		Fourmile Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0737382102	-112.210233196							Grand Canyon National Park 2010b	
417	NPS_All_Hydro	BA-62				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.0899582611	-112.15695913							Grand Canyon National Park 2010b	
418	NPS_All_Hydro	HP-10				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1876912242	-112.332743536							Grand Canyon National Park 2010b	
419	NPS_All_Hydro	HP-10b				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1868318175	-112.33075996							Grand Canyon National Park 2010b	
420	NPS_All_Hydro	HP-15				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1768037981	-112.33455179							Grand Canyon National Park 2010b	
421	NPS_All_Hydro	HP-15c				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1765754635	-112.331521322							Grand Canyon National Park 2010b	
422	NPS_All_Hydro	HP-15e				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1786165159	-112.323621859							Grand Canyon National Park 2010b	
423	NPS_All_Hydro	HP-18a				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1693754312	-112.323407664							Grand Canyon National Park 2010b	
424	NPS_All_Hydro	HP-20				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1606147287	-112.324993716							Grand Canyon National Park 2010b	
425	NPS_All_Hydro	HP-20a				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1558010427	-112.325411427							Grand Canyon National Park 2010b	
426	NPS_All_Hydro	HP-20b				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1578347	-112.327318471							Grand Canyon National Park 2010b	
427	NPS_All_Hydro	HP-22b				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1414116465	-112.324439617							Grand Canyon National Park 2010b	
428	NPS_All_Hydro	HP-22c				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.140303416	-112.327036831							Grand Canyon National Park 2010b	
429	NPS_All_Hydro	HP-23				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1440819236	-112.304979447							Grand Canyon National Park 2010b	
430	NPS_All_Hydro	HP-24				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1356886224	-112.30009232							Grand Canyon National Park 2010b	
431	NPS_All_Hydro	HP-24c				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1298490541	-112.30651181							Grand Canyon National Park 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
432	NPS_All_Hydro	HP-25				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1322365946	-112.285548699							Grand Canyon National Park 2010b	
433	NPS_All_Hydro	HP-25a				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1266765849	-112.290103806							Grand Canyon National Park 2010b	
434	NPS_All_Hydro	HP-25d				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1334675411	-112.279222433							Grand Canyon National Park 2010b	
435	NPS_All_Hydro	HP-27a				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.121719528	-112.276544564							Grand Canyon National Park 2010b	
436	NPS_All_Hydro	HP-27c				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1172320779	-112.281815883							Grand Canyon National Park 2010b	
437	NPS_All_Hydro	HP-27d				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1241722735	-112.269918411							Grand Canyon National Park 2010b	
438	NPS_All_Hydro	HP-27e				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1241074418	-112.267039594							Grand Canyon National Park 2010b	
439	NPS_All_Hydro	HP-27g				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.124259704	-112.263899975							Grand Canyon National Park 2010b	
440	NPS_All_Hydro	HP-27h				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1242701347	-112.2583795							Grand Canyon National Park 2010b	
441	NPS_All_Hydro	HP-65b				South Buffer	Grand Canyon - South Rim	Regional	Spring				36.1780047347	-112.459314565							Grand Canyon National Park 2010b	
442	NPS_All_Hydro	VT-10		O' Neill Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.0175105715	-111.977750482							Grand Canyon National Park 2010b	Formation assigned from M&A1998
443	GCNP-1	GARD004	1	Two Tree Spring at Gage near Pumphouse		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Bright Angel Sh			36.078339568	-112.126405567	04-Jan-05	30-Dec-08	37.8	55.2	47.1681692	25	Grand Canyon National Park 2010a	
443	M&A-93b	IG	2	Indian Garden Creek at pump house		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Redwall-Muav Aquifer			36.078889	-112.126944							M&A 1993b	
443	Liebe-03	IG-UP	3	Indian Garden Creek; sidestream near pumphouse station at campground		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Muav Ls			36.078333	-112.125833	04-Jun-02	24-Jun-02	300	300	300	1	Liebe 2003	Sample Taken at Smaller Sidestream near Pumphouse Station at Campground; Elevation 3812 Feet Above Mean Sea Level; 3380 Feet Below South Rim
443	Liebe-03	IG-DOWN	4	Indian Garden Creek; 100' Downstream from Indian Garden Up site		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Muav Ls			36.07865	-112.12581							Liebe 2003	Sample Taken 100 Feet Downstream from Ig Up; Next to Bright Angel Trail
443	NWIS-2	360441112073202	5	A-31-02 12 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring stream				36.07803835	-112.1262803							USGS 2010b	
443	Monroe-05	360441112073202	6	Pumphouse Wash Gage; mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Alluvium			36.0764501593	-112.125633426							Monroe et al. 2005	
444	Liebe-03	H-EA		Horn Creek at potential downstream flow of Horn Creek Up and Down sites		South Buffer	Grand Canyon - South Rim	Regional	Stream	Redwall-Muav Ls			36.08325	-112.14364							Liebe 2003	Sample Taken at Potential Downstream Flow of Horn Creek Up and Horn Creek Down; 400 Foot Vertical Elevation Difference
446	Taylor-04	HANCE-RP-SP		Hance Rapid Spring		South Buffer	Grand Canyon - East	Below regional	Spring	Quartzite/schist			36.0538703487	-111.9229303567							Taylor et al. 2004	Reported Location Utm (416872,3990117)

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
447	STORET-1	GRCA_NPS_ TANN02		Tanner Canyon Spring		South Buffer	Grand Canyon - East	Below regional	Spring				36.0903056	-111.8266167							USEPA 2010	Tanner Canyon is Located Within the Boundary of Grand Canyon National Park near Colorado River Mile 69 at River Left. the Actual Location of the Spring in Tanner Canyon is Not Known and the Given Location is General Location in Central Tanner Canyon. Not
448	NPS_All_Hydro	BA-12				South Buffer	Grand Canyon - East	Below regional	Spring				36.0684456344	-112.020726718							Grand Canyon National Park 2010b	
449	NPS_All_Hydro	VT-25				South Buffer	Grand Canyon - East	Below regional	Spring				36.0849853259	-111.854887905							Grand Canyon National Park 2010b	
450	NPS_All_Hydro	VT-51				South Buffer	Grand Canyon - East	Below regional	Spring				36.0458822944	-111.927153193							Grand Canyon National Park 2010b	
451	Monroe-05	360411112141701	1	Boucher East Spring; upper Tapeats (Travertine dome)		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss			36.1007013515	-112.237245484	26-May-00	12-Apr-01	4.488312	4.488312	4.488312	1	Monroe et al. 2005	
451	NWIS-2	360411112141701	2	A-31-01 01 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Bright Angel Sh			36.06970456	-112.2387835							USGS 2010b	
452	NWIS-2	360513112044001		A-31-03 15 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.0869274	-112.0785013							USGS 2010b	
453	STORET-1	GRCA_FIT_ LONE02	1	LoneTree Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh		Contact	36.0715972	-112.0460028							USEPA 2010	the Lower Lonetree Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in Lonetree Canyon. the Spring Discharges from the Tapeats Sandstone-Bright Angle Shale Contact But the Actual Spring Orifice is Buried By Modern Sedim
453	GCNP-1	LONE002	2	LoneTree near Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss			36.0715972	-112.0460028	15-Dec-04	05-Nov-08	0	15.8	2.9126729173	6	Grand Canyon National Park 2010a	
453	Fitz-96	LONE	3	LoneTree Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	U. Tapeats Ss	Intermittent	Fold axis	36.0711667	-112.0455	09-Jan-94	18-Jul-95	0.75	0.75	0.75	1	Fitzgerald 1996	
453	NWIS-2	360418112024710	4	BA22 LoneTree Spring at Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Bright Angel Sh			36.07164988	-112.0471113							USGS 2010b	
454	STORET-1	GRCA_FIT_ BLDR03	1	Boulder Creek Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent		36.056187	-112.0350906							USEPA 2010	Boulder Creek Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Boulder Creek Drainage. the Spring Flows from the Tapeats Sandstone near the Tonto Trail and is Dry the Majority of the Time.
454	Fitz-96	BLDR	2	Boulder Creek (Spring)		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent		36.056187	-112.035091							Fitzgerald 1996	
454	GCNP-1	BLDR003	3	Boulder Creek		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent		36.056187	-112.0350906	18-Oct-06	18-Oct-06	0.877	0.877	0.877	1	Grand Canyon National Park 2010a	Coord from Storet Grca_Nps_Bldr03; Spring Flows from the Tapeats Sandstone near the Tonto Trail and is Dry the Majority of the Time.
455	Fitz-96	CEDA	1	Cedar Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh	Intermittent		36.08974	-112.17856	18-Mar-95	26-Nov-95	0.5	0.5	0.5	2	Fitzgerald 1996	
455	GCNP-1	CEDR002	2	Cedar Spring below Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss			36.089741669	-112.17893611	06-Jan-06	13-Nov-08	0	3.949704	0.6466905521	8	Grand Canyon National Park 2010a	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
455	STORET-1	GRCA_FIT_ CEDR02	3	Cedar Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh		Contact	36.0888932	-112.1780801							USEPA 2010	Cedar Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Drainage East of Monument Creek. the Spring Discharges from the Tapeats Sandstone-Bright Angel Shale Contact near the Tonto Trail and is Dry in the Summer Mo
456	STORET-1	GRCA_FIT_ COTT08	1	Cottonwood West Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent		36.0368578	-111.9974578							USEPA 2010	Cottonwood West Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Far Western Tributary of Cottonwood Creek. the Spring Discharges a Small Volume Intermittently from the Tapeats Sandstone.
456	Fitz-96	COTT-W	2	Cottonwood West Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh	Intermittent		36.036858	-111.9974578							Fitzgerald 1996	
456	GCNP-1	COTT006	3	Cottonwood Far West		South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.036792	-111.99749	17-Oct-06	05-Nov-08	0	5.77	1.154	5	Grand Canyon National Park 2010a	
457	Fitz-96	MONU	1	Monument Creek / Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	U. Tapeats Ss	Intermittent		36.08233	-112.185667	18-Mar-95	25-Nov-95	5	5	5	1	Fitzgerald 1996	
457	STORET-1	GRCA_FIT_ MONU05	2	Monument Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh		Contact	36.082333	-112.185667							USEPA 2010	Monument Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Monument Creek Drainage, near the Tonto Trail. the Spring Discharges from the Tapeats Sandstone-Bright Angel Shale Contact. Samples Were Collected from Th
457	NWIS-2	360455112110800	3	A-31-02 09 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss			36.0819269	-112.1868377	24-May-00	05-Dec-00	53.859744	53.859744	53.859744	1	USGS 2010b	
458	STORET-1	GRCA_FIT_ CREM03	1	Cremation Creek Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring		Intermittent		36.08345	-112.0697111							USEPA 2010	Cremation Creek Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Cremation Creek Drainage. the Spring is Dry the Majority of the Time and Abundant Salt Precipitate Occurs in the Creek Bed. Cremation Creek Spring
458	Fitz-96	CREM	2	Cremation Creek (Spring)		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent		36.08345	-112.0697111							Fitzgerald 1996	
459	GCNP-1	LONE004		LoneTree at Lone Cottonwood		South Buffer	Grand Canyon - South Rim	Below regional	Spring	PC meta/ig			36.07425	-112.0407	19-Oct-06	19-Nov-07	0.5	0.5	0.5	1	Grand Canyon National Park 2010a	
460	NHD-1	128914664				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1454106106	-112.318941469							USGS 2007	
461	NPS_All_Hydro	BA-1				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1273190532	-112.243557402							Grand Canyon National Park 2010b	
462	NPS_All_Hydro	BA-3c				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1132271743	-112.237224435							Grand Canyon National Park 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
463	NPS_All_Hydro	BA-5				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1009600759	-112.219865206							Grand Canyon National Park 2010b	
464	NPS_All_Hydro	BA-5b				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1028039087	-112.219017491							Grand Canyon National Park 2010b	
465	NPS_All_Hydro	HP-15f				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.180294871	-112.322650977							Grand Canyon National Park 2010b	
466	NPS_All_Hydro	HP-20c				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1596295715	-112.319277781							Grand Canyon National Park 2010b	
467	NPS_All_Hydro	HP-21				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1596013862	-112.315340641							Grand Canyon National Park 2010b	
468	NPS_All_Hydro	HP-22				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1432250779	-112.322698606							Grand Canyon National Park 2010b	
469	NPS_All_Hydro	HP-22a				South Buffer	Grand Canyon - South Rim	Below regional	Spring				36.1504991513	-112.314366348							Grand Canyon National Park 2010b	
470	GCNP-1	PIPE003	1	Burro Spring below Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring stream	Tapeats Ss			36.076970284	-112.102883686	04-Jan-05	06-May-08	0.077	15.8	5.0720619912	10	Grand Canyon National Park 2010a	
470	NWIS-2	360436112060401	2	A-31-03 17 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring stream	Bright Angel Sh			36.07664959	-112.1018352							USGS 2010b	
470	Monroe-05	360436112060401	3	Burro Spring; lower Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Below regional	Spring stream	Alluvium			36.0748218335	-112.100268106	22-May-00	08-Apr-01	4.488312	4.488312	4.488312	1	Monroe et al. 2005	
472	Monroe-05	360415112060601	1	Pipe Creek; lower Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium			36.0675159426	-112.099183347							Monroe et al. 2005	
472	NWIS-2	09403010	2	Pipe Spring Creek above Tonto Trail near Grand Canyon, AZ		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.0719274	-112.1021129	22-Sep-94	09-Sep-03	4.0394808	71.3641608	13.0036372667	36	USGS 2010b	
472	GCNP-1	PIPE002	3	Pipe Creek above Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	Bright Angel Sh			36.071106394	-112.101841251	04-Jan-05	30-Dec-08	3.8	15.5	8.9363181818	11	Grand Canyon National Park 2010a	
473	NWIS-2	09403015		Garden Creek below Indian Garden near Grand Canyon, AZ		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.0833161	-112.1243359	23-Sep-94	19-Apr-97	251.345472	1018.846824	699.6779706667	18	USGS 2010b	
474	GCNP-1	HERM004	1	Hermit Creek at gage		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss			36.080597227	-112.214152776	07-Jan-05	12-Nov-08	207	528.72174	338.6548535714	14	Grand Canyon National Park 2010a	
474	NWIS-2	09403043	2	Hermit Creek above Tonto Trail near Grand Canyon, AZ		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.08081566	-112.2137829	27-Sep-94	17-Jan-03	179.53248	462.296136	312.5676225263	57	USGS 2010b	
475	GCNP-1	MONU002	1	Monument Creek at Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	PC Meta/Ig			36.0818938	-112.1862363	06-Jan-05	28-Nov-07	48	87	60.9908857143	7	Grand Canyon National Park 2010a	
475	NWIS-2	09403033	2	Monument Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.0833333	-112.186111	18-Nov-01	18-Sep-03	22.8903912	62.836368	40.589952	23	USGS 2010b	
476	Liebe-03	IG-CC		Indian Garden Creek; 600' Upstream from Mixing Confluence site		South Buffer	Grand Canyon - South Rim	N/A	Stream	Muav Ls			36.092778	-112.111389							Liebe 2003	Sample Taken 600 Feet Upstream from the Mixing Confluence of Unnamed Crystalline Core Stream and Garden Creek; Elevation 2654 Feet Above Mean Sea Level

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
477	Liebe-03	MC		Confluence of unnamed crystalline core stream and Garden Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.0941	-112.11194							Liebe 2003	Sample Taken at Mixing Confluence of Unnamed Crystalline Core Creek and Garden Creek; Sampled Three Times Between July 15 - August 16, 2002 Downstream from Mixing Point One Mile Upstream from Confluence With Colorado River; Elevation 2588 Feet Above Mean
478	Liebe-03	UCC		Pipe Creek basin; exposed, remote point directly above 100' waterfall		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss			36.08848	-112.11283							Liebe 2003	Spring Issues at Indian Garden Campground, Meanders Through Tapeats Sandstone and Inner Gorge Into Colorado River; Collects Water Along the Way from This Unnamed Spring, Which Issues Below the Base of Tapeats Sandstone Where Garden Creek and Pipe Creek Me
479	Liebe-03	P-CC		Pipe Creek; 0.8 miles upstream from mixing confluence in Pipe Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.08495	-112.10861							Liebe 2003	Pipe Creek in the Inner Gorge; Samples 0.8 Miles Upstream from Mixing Confluence in Pipe Creek; Water Barely Visible at This Site; Samples Collected By Damming Water Before Sampling; Elevation 3113 Feet Above Mean Sea Level
480	STORET-1	GRCA_FIT_ SALT02	1	Salt Creek at the Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss			36.0849333	-112.1626083							USEPA 2010	Salt Creek Spring is Located in the South Rim Within the Boundary of Grand Canyon National Park in the Salt Creek Drainage, near the Tonto Trail. the Seeps Flow from the Tapeats Sandstone, Mainly from An Opening in Cross-Bedding.
480	GCNP-1	SALT002	2	Salt Creek Below Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss			36.084992657	-112.162621723	05-Jan-05	13-Nov-08	0.407	61.04088	10.104179305	9	Grand Canyon National Park 2010a	
480	Fitz-96	SALT	3	Salt Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss	Intermittent	Bedding Planes	36.08533	-112.161833	19-Mar-95	26-Nov-95	0.3	0.3	0.3	1	Fitzgerald 1996	
481	GCNP-1	BLDR002		Boulder canyon above the Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.056906141	-112.036262236	15-Dec-04	30-Dec-09	0	10	1.921730023	7	Grand Canyon National Park 2010a	
482	GCNP-1	BOUC006		Boucher near Tonto Trail/Campsites		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.106472898	-112.239983348							Grand Canyon National Park 2010a	
483	GCNP-1	GRAP005		Grapevine Canyon at Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream				36.036281832	-112.022078227	14-Dec-04	05-Nov-08	0	25	7.3951326959	7	Grand Canyon National Park 2010a	
484	GCNP-1	HORN002	1	Horn Creek at Phone (or power) lines		South Buffer	Grand Canyon - South Rim	N/A	Stream	Bright Angel Sh			36.0785692	-112.1432629	05-Jan-05	14-Nov-08	0	12.2	2.4215150912	8	Grand Canyon National Park 2010a	
484	Monroe-05	360450112083601	2	Horn Creek; mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium			36.0786398318	-112.142948991							Monroe et al. 2005	
485	GCNP-1	MONU004		Monument Creek at Monument		South Buffer	Grand Canyon - South Rim	N/A	Stream	PC Meta/Ig			36.0844444	-112.1886111	04-Mar-08	12-Nov-08	55.1	55.1	55.1	1	Grand Canyon National Park 2010a	
486	Monroe-05	360128111591501		Cottonwood Creek No. 1; lower Bright Angel alluvium		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium			36.022599929	-111.986669592							Monroe et al. 2005	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
487	Monroe-05	360455112111001		Monument Creek No. 1; Tapeats (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium			36.0800700272	-112.185485369							Monroe et al. 2005	
490	NWIS-2	355142111234301		03 98-07.70X09.60			Cameron, AZ	Mesozoic	Spring				35.86166216	-111.3959763							USGS 2010b	
491	NWIS-2	355326111243501		03 98-09.05X07.63			Cameron, AZ	Mesozoic	Spring				35.89055046	-111.4104205							USGS 2010b	
492	NWIS-2	355141111234301		03-098 08.13X09.52			Cameron, AZ	Mesozoic	Spring	Shinarump Mbr			35.86138438	-111.3959763	17-Oct-01	17-Oct-01	0.13	0.13	0.13	1	USGS 2010b	
493	NWIS-2	355129111263301		03-098 10.79X09.72			Cameron, AZ	Mesozoic	Spring	Moenkopi Fm			35.85805107	-111.4431991							USGS 2010b	
494	GWSI-1	353118111223101	1	Wupatki Spring; A-25-10 30BBC			Coconino Plateau - East	Mesozoic	Spring	Moenkopi Fm	Perennial	Contact	35.521670551	-111.375983183	22-Oct-54	22-Oct-54	0.12	0.12	0.12	1	ADWR 2009b	
494	NWIS-2	353118111223101	2	A-25-10 30BBC			Coconino Plateau - East	Mesozoic	Spring	Moenkopi Fm			35.5216702	-111.375983							USGS 2010b	
495	NWIS-2	353021111211401		A-25-10 32BDB			Coconino Plateau - East	Mesozoic	Spring	Moenkopi Fm			35.50583715	-111.3545937							USGS 2010b	
496	GWSI-1	353328112354201		Howard Spring; B-25-03 15BBA			Coconino Plateau - West	Mesozoic	Spring				35.557774909	-112.59573477							ADWR 2009b	
497	NURE	23078					Coconino Plateau - West	Mesozoic	Spring				35.563596743	-112.585234644							USGS 2009b	
498	NURE	23081					Coconino Plateau - West	Mesozoic	Spring				35.641493416	-112.687238785							USGS 2009b	
499	GCWC-02	LM-4-1		Ambush Spring #1; B-31-11 22BD			Grand Canyon - West	Mesozoic	Spring	Basalt	Perennial	Contact; Fracture	36.07178	-113.45886	18-Jun-00	18-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, North End of Kelly Point Road, Eight Miles Southeast of Mt. Dellenbaugh Lmnra Fire Camp Cabins
500	GCWC-02	LM-4-2		Ambush Spring #2; B-31-11 22CA			Grand Canyon - West	Mesozoic	Spring	Basalt	Perennial	Fracture	36.07069	-113.45859	18-Jun-00	18-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, North End of Kelly Point Road, Eight Miles Southeast of Mt. Dellenbaugh Lmnra Fire Camp Cabins
501	GWSI-1	363120113193001	1	Russell Spring; B-36-10 13BCC			Hurricane Valley	Mesozoic	Spring	Coconino Ss	Perennial	Fracture	36.522203339	-113.325778085	21-Jul-51	21-Jul-51	1	1	1	1	ADWR 2009b	
501	NWIS-2	363120113193001	2	B-36-10 13BCC			Hurricane Valley	Mesozoic	Spring	Coconino Ss			36.52220356	-113.325778							USGS 2010b	
502	NURE	GCAC501R					Hurricane Valley	Mesozoic	Spring	MNKP Ss			36.945983511	-113.35568342							USGS 2009b	
503	BLM-Legacy	LEG-201		Coyote Spring; B-41-10 22CDB			Hurricane Valley	Mesozoic	Spring				36.93639	-113.36496	01-Jul-85	01-Jul-85	1	1	1	1	BLM 2010d	Piped Off at Source/ Overflow to Pond from Trough
504	BLM-Legacy	LEG-46		Russel Spring; B-36-10 13CA			Hurricane Valley	Mesozoic	Spring				36.52015	-113.31962							BLM 2010d	Seep from a Cave Pool/ Subject to Flash Floods/ Atkins Feel It is Not Worth Fixing
505	GCWC-02-Map	M-378		Sand Spring; B-41-10 22BAA			Hurricane Valley	Mesozoic	Spring				36.94578	-113.36237							Grand Canyon Wildlands Council 2002	
506	NWIS-2	365853112380901	1	Wolf Spring; B-41-03 05 UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Petrified Forest Mbr			36.9813742	-112.636593							USGS 2010b	
506	GCWC-02-Map	M-466	2	Wolf Spring; B-41-03 05D			Kaibab Paiute Reservation	Mesozoic	Spring				36.98131	-112.63617							Grand Canyon Wildlands Council 2002	
507	GWSI-1	365829112360101	1	Cottonwood Spring; B-41-03 10A			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr	Perennial	Contact	36.974707625	-112.601036649							ADWR 2009b	
507	NWIS-2	365829112360101	2	B-41-03 10ABA			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr			36.97470784	-112.6010364	23-Apr-73	23-Apr-73	4.5	4.5	4.5	1	USGS 2010b	
508	GCWC-02-Map	M-153	1	Riggs Spring; B-41-03 16C			Kaibab Paiute Reservation	Mesozoic	Spring				36.9484	-112.62502							Grand Canyon Wildlands Council 2002	
508	GWSI-1	365650112372601	2	Riggs Spring; B-41-03 16C			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr	Perennial	Contact	36.947207717	-112.624647164							ADWR 2009b	
508	NWIS-2	365650112372601	3	B-41-03 16CDC UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr			36.9485968	-112.6254805	23-Apr-73	23-Apr-73	1.8	1.8	1.8	1	USGS 2010b	
508	NURE	GCAF505R	4				Kaibab Paiute Reservation	Mesozoic	Spring	CHNL Ss			36.9480857	-112.625358215							USGS 2009b	
509	NWIS-2	365738112390801	1	Pine Spring; B-41-03 18 UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr			36.96054097	-112.6529816							USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
509	GCWC-02-Map	M-468	2	Pine Spring; B-41-03 18AAA			Kaibab Paiute Reservation	Mesozoic	Spring				36.96028	-112.65266							Grand Canyon Wildlands Council 2002	
510	GCWC-02-Map	M-472	1	Point Spring; B-41-04 28D			Kaibab Paiute Reservation	Mesozoic	Spring				36.92127	-112.72314							Grand Canyon Wildlands Council 2002	
510	GWSI-1	365516112432201	2	Point Spring; B-41-04 28DAD			Kaibab Paiute Reservation	Mesozoic	Spring		Perennial	Fracture	36.921096241	-112.72353787	23-Apr-73	23-Apr-73	0.6	0.6	0.6	1	ADWR 2009b	
510	NWIS-2	365516112432201	3	B-41-04 28DAC			Kaibab Paiute Reservation	Mesozoic	Spring	Moenave Fm			36.92109635	-112.7235376							USGS 2010b	
510	NURE	GCAF504R	4				Kaibab Paiute Reservation	Mesozoic	Spring	MNKP Ss			36.921285243	-112.722759855							USGS 2009b	
511	NWIS-2	365934112412501		B-42-04 35 UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Navajo Ss			36.9927627	-112.6910392							USGS 2010b	
512	NURE	GCAE503R					Kaibab Paiute Reservation	Mesozoic	Spring				36.933184841	-112.82796383							USGS 2009b	
513	GCWC-02-Map	M-475	1	Burnt Corral Spring; B-41-05 13ADD			Kaibab Paiute Reservation	Mesozoic	Spring				36.95547	-112.77571							Grand Canyon Wildlands Council 2002	
513	NURE	GCAE515R	2				Kaibab Paiute Reservation	Mesozoic	Spring	TRSS Ss			36.956084772	-112.777062589							USGS 2009b	
514	NURE	GCAE516R					Kaibab Paiute Reservation	Mesozoic	Spring	TRSS Ss			36.995084509	-112.782863875							USGS 2009b	
515	GCWC-02-Map	M-149	1	Red Cliff Spring; B-41-04 01AD			Kaibab Paiute Reservation	Mesozoic	Spring				36.98523	-112.68887							Grand Canyon Wildlands Council 2002	
515	NURE	GCAF503R	2				Kaibab Paiute Reservation	Mesozoic	Spring	MNKP Ss			36.984384997	-112.689261072							USGS 2009b	
516	BLM-Legacy	LEG-234		Cane Spring; B-41-05 22CCC			Kaibab Paiute Reservation	Mesozoic	Spring				36.93324	-112.82761	01-Jul-85	01-Jul-85	1.8	1.8	1.8	1	BLM 2010d	May Be Referred to As Bull Pasture Spring
517	BLM-Legacy	LEG-229		Hole in the Rock Spring; B-41-03 06AAC			Kaibab Paiute Reservation	Mesozoic	Spring				36.98759	-112.65374	01-Jul-85	01-Jul-85	0.2	0.2	0.2	1	BLM 2010d	Pools 6' × 6' × 1',1' × 6' × 1'/Water Flows for 65' on Surface/Wet Area 6' × 10'
518	GCWC-02-Map	M-182		Willow Spring; B-41-04 06D			Kaibab Paiute Reservation	Mesozoic	Spring				36.98017	-112.76092							Grand Canyon Wildlands Council 2002	
519	GCWC-02-Map	M-129		Upper Moccasin Spring; B-41-05 26C			Kaibab Paiute Reservation	Mesozoic	Spring				36.92022	-112.80643							Grand Canyon Wildlands Council 2002	
520	GCWC-02-Map	M-469		Auston Spring; B-41-03 30DA			Kaibab Paiute Reservation	Mesozoic	Spring				36.92382	-112.65211							Grand Canyon Wildlands Council 2002	
521	GCWC-02-Map	M-2		Bull Pasture Spring; B-41-05 26A			Kaibab Paiute Reservation	Mesozoic	Spring				36.93206	-112.79921							Grand Canyon Wildlands Council 2002	No Spring on Topo Map
522	Taylor-97	FOUR-MI-SP		Four Mile Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring				36.87511111	-111.5071111							Taylor et al. 1997	
523	Taylor-97	POWER-SP		Power Lines Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring	Navajo Ss			36.92697222	-111.4921111							Taylor et al. 1997	
524	Taylor-97	SEWA-SP		Sewage Ponds Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring				36.91180556	-111.4783056							Taylor et al. 1997	
525	BLM-Legacy	LEG-258	1	Cottonwood Spring; B-42-06 34DDD			Moccasin Mountains	Mesozoic	Spring				36.9908	-112.92097	07-Aug-84	07-Aug-84	3.8	3.8	3.8	1	BLM 2010d	
525	GWSI-1	365925112551201	2	Cottonwood Spring; B-42-06 34DDD			Moccasin Mountains	Mesozoic	Spring	Navajo Ss		Fracture	36.990262359	-112.920768349							ADWR 2009b	
525	NWIS-2	365925112551201	3	B-42-06 34DDD			Moccasin Mountains	Mesozoic	Spring	Navajo Ss			36.99026214	-112.9207683							USGS 2010b	
525	NURE	GCAE509R	4				Moccasin Mountains	Mesozoic	Spring	TRSS Ss			36.990284362	-112.92076835							USGS 2009b	
526	BLM-Legacy	LEG-238		Finnicum Seeps; B-41-06 01AC			Moccasin Mountains	Mesozoic	Spring				36.98464	-112.89053	01-Jul-85	01-Jul-85	0.3	0.3	0.3	1	BLM 2010d	Allotment #4026 Turned Over to Utah Blm,Dixie Resource Area/No File on Spring Improvement at Finnicum Spring/Buried Head Box

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
527	BLM-Legacy	LEG-255		Finnicum Spring; B-42-06 36AA			Moccasin Mountains	Mesozoic	Spring				36.99907	-112.885							BLM 2010d	
528	BLM-Legacy	LEG-233		Parashont Spring; B-41-05 09DB			Moccasin Mountains	Mesozoic	Spring				36.96724	-112.83546	01-Jul-85	01-Jul-85	1.8	1.8	1.8	1	BLM 2010d	
529	BLM-Legacy	LEG-257		Stateline Spring; B-42-06 35BA			Moccasin Mountains	Mesozoic	Spring				36.99672	-112.90543	07-Aug-84	07-Aug-84	4.3	4.3	4.3	1	BLM 2010d	Development Washed Out
530	BLM-Legacy	LEG-256		Maidenhair Spring; B-42-06 35AB			Moccasin Mountains	Mesozoic	Spring				36.99936	-112.9098	08-Jul-84	08-Jul-84	3.9	3.9	3.9	1	BLM 2010d	Development Type: Cutoff Dike
531	NWIS-2	360840111200501		03 078-04.75X07.27			Painted Desert	Mesozoic	Spring	Navajo Ss			36.1444362	-111.3354195							USGS 2010b	
532	BLM-Legacy	LEG-231		Sand Spring; A-42-04 32C			Paria Plateau	Mesozoic	Spring				36.99764	-111.99389	01-Jul-85	01-Jul-85	2.5	2.5	2.5	1	BLM 2010d	Spring Was Developed in 1963 Under a.P. Sanders:Jdr #1384/ Development No Longer at Site,or There Are Two Sand Springs
533	BLM-Legacy	LEG-235		Bush Head Canyon; A-41-06 23DA			Paria Plateau	Mesozoic	Spring				36.93845	-111.71227	01-Jul-85	01-Jul-85	6	6	6	1	BLM 2010d	Light Livestock Use
534	BLM-Legacy	LEG-236		Last Springs; A-41-06 15DD			Paria Plateau	Mesozoic	Spring				36.94897	-111.73122	01-Jul-85	01-Jul-85	4.5	4.5	4.5	1	BLM 2010d	Light Cattle Use/Actually Two Springs Located at Site/One Estimated at 2.5 Gallons per Minute,Other Main Spring at 1.5 Gallons per Minute
535	BLM-Legacy	LEG-240		Wilson Spring; A-41-07 34CBA			Paria Plateau	Mesozoic	Spring				36.9096	-111.63321							BLM 2010d	Spring is Recommended for Fencing and Gabbtons Needed in Few Spots Along River Bank/Old (Non-Functional) Pipelines and Concrete Head Box Above Present Spring Source/No Disch
536	BLM-Legacy	LEG-237		Wrather Spring; A-41-06 08CC			Paria Plateau	Mesozoic	Spring				36.96255	-111.77967	01-Jul-85	01-Jul-85	4	4	4	1	BLM 2010d	Beaver Sighting
537	GCWC-02-Map	M-74		A-41-07 34C			Paria Plateau	Mesozoic	Spring				36.9088	-111.63337							Grand Canyon Wildlands Council 2002	
538	BLM-Legacy	LEG-239		A-41-07 34B (seep)			Paria Plateau	Mesozoic	Spring				36.91434	-111.63406	06-Apr-82	06-Apr-82	9	9	9	1	BLM 2010d	Spring Just Northwest of Wilson Spring/Flow Rate 5-10 Gallons per Minute/No Fences/Light Deer Use
539	GCWC-02	LM-3	1	Green Spring; B-31-11 09CD			Shivwits Plateau	Mesozoic	Spring	Basalt	Perennial	Contact	36.09415	-113.47441	18-Jun-00	14-Aug-01	4	5	4.5	2	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, North End of Kelly Point Road, Six Miles Southeast of Mount Dellenbaugh Lmnra Fire Camp Cabins;
539	NWIS-2	360538113282501	2	B-31-11 09CDD			Shivwits Plateau	Mesozoic	Spring	Basaltic Flows			36.0938727	-113.4743803							USGS 2010b	
540	NWIS-2	362340113282301	1	Ivan Patch Spring; B-35-11 33ABD			Shivwits Plateau	Mesozoic	Spring	Basaltic Flows			36.3944248	-113.473832							USGS 2010b	
540	BLM-Legacy	LEG-34	2	Ivan Patch Spring; B-35-11 33AB			Shivwits Plateau	Mesozoic	Spring				36.39281	-113.47293							BLM 2010d	10 Foot Tunnel
541	GCWC-02	BLM 151	1	Poverty Spring; B-35-12 26DC			Shivwits Plateau	Mesozoic	Spring	Moenkopi Fm		Contact	36.39852	-113.54803	16-Jun-00	16-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, Southwest End of Poverty Mountain, 2 Miles Northeast of Poverty Administration Site.
541	BLM-Legacy	LEG-37	2	Poverty Spring; B-35-12 26DC			Shivwits Plateau	Mesozoic	Spring				36.39852	-113.54803	01-Jul-85	01-Jul-85	0.6	0.6	0.6	1	BLM 2010d	Additional Jdr:4260/"Coop" Agreement on Water Amount:2/3 to Roland Esplin and 1/3 to Administration Site of 2000 Gallon Storage Tank/Spring Drains Into Parashaunt Canyon (We
541	NWIS-2	362355113325101	3	B-35-12 26DCC			Shivwits Plateau	Mesozoic	Spring	Basaltic Flows			36.39859177	-113.5482788	08-Sep-76	08-Sep-76	1	1	1	1	USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
542	Hopkins-84a	GW025W					Shivwits Plateau	Mesozoic	Spring				36.225259308	-113.554383554							Hopkins et al. 1984a	
543	Hopkins-84a	GW026W					Shivwits Plateau	Mesozoic	Spring				36.230814765	-113.559105995							Hopkins et al. 1984a	
544	Hopkins-84a	GW028WA					Shivwits Plateau	Mesozoic	Spring				36.145260392	-113.48799177							Hopkins et al. 1984a	
545	Hopkins-84a	GW031W					Shivwits Plateau	Mesozoic	Spring				36.224147912	-113.535771535							Hopkins et al. 1984a	
546	Hopkins-84a	GW032W					Shivwits Plateau	Mesozoic	Spring				36.246924441	-113.501325446							Hopkins et al. 1984a	
547	NURE	GCCC501R					Shivwits Plateau	Mesozoic	Spring	QTRN Volcanics - Mafic			36.382780368	-113.462575645							USGS 2009b	
548	GCWC-02	BLM 152	1	Dewdrop Spring; B-35-12 36BA			Shivwits Plateau	Mesozoic	Spring	Moenkopi Fm - Q Landslide		Contact	36.39472	-113.53114	16-Jun-00	16-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, South End of Poverty Mountain, 3 Miles East of Poverty Administration Site.
548	BLM-Legacy	LEG-36	2	Dewdrop Spring; B-35-12 36BA			Shivwits Plateau	Mesozoic	Spring				36.39472	-113.53114	08-May-85	08-May-85	1.7	1.7	1.7	1	BLM 2010d	Spring Drains Into Parashaunt Canyon (West Fork)
549	GCWC-02	BLM 163	1	Salt Spring; B-34-11 06CD			Shivwits Plateau	Mesozoic	Spring	Moenkopi Fm	Perennial	Contact	36.37146	-113.51327	16-Jun-00	16-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, South End of Poverty Mountain, 4 Miles Southeast of Poverty Administration Site.
549	BLM-Legacy	LEG-16	2	Salt Spring; B-34-11 06CD			Shivwits Plateau	Mesozoic	Spring				36.37146	-113.51327	01-Jul-85	01-Jul-85	0.1	0.1	0.1	1	BLM 2010d	Headbox Rusted Out/ System Non-Functional/ Large Storage Tank
550	GCWC-02	GCNP-109		Deer Creek new river; B-35-02 28D			Shivwits Plateau	Mesozoic	Spring	Tapeats Ss	Intermittent	Contact	36.38853	-113.50917	03-Apr-01	03-Apr-01	3.9	3.9	3.9	1	Grand Canyon Wildlands Council 2002	in Deer Creek Canyon, Approximately 1.1 Miles from the Colorado River at River Mile 136.3
551	BLM-Legacy	LEG-35		New Spring; B-35-11 20DB			Shivwits Plateau	Mesozoic	Spring				36.41674	-113.49562	07-May-85	07-May-85	4.5	4.5	4.5	1	BLM 2010d	Tunneled Into Formation Approximately 100 Feet
552	GCWC-02-Map	M-285		Dead Drop Spring? Dewdrop Spring; B-35-11 31			Shivwits Plateau	Mesozoic	Spring				36.39328	-113.51496							Grand Canyon Wildlands Council 2002	
553	BLM-Legacy	LEG-8		Andrus Lower Spring; B-33-11 20CA			Shivwits Plateau	Mesozoic	Spring				36.24286	-113.50366	01-Jul-85	01-Jul-85	0.2	0.2	0.2	1	BLM 2010d	
554	BLM-Legacy	LEG-9		Andrus Upper Spring; B-33-11 20CA			Shivwits Plateau	Mesozoic	Spring				36.24424	-113.50365	01-Jul-85	01-Jul-85	1.2	1.2	1.2	1	BLM 2010d	
555	BLM-Legacy	LEG-11		Log Spring/Pond; B-33-12 35AD			Shivwits Plateau	Mesozoic	Spring				36.219	-113.5425							BLM 2010d	Spring Drains Into Parashaunt Canyon (East Fork)
556	GCWC-02-Map	M-219		B-33-12 35AA			Shivwits Plateau	Mesozoic	Spring				36.22285	-113.54312							Grand Canyon Wildlands Council 2002	No Spring on Topo
557	GWSI-1	365654113032001	1	Lost Spring; B-41-07 16CDD			Uinkaret Plateau - North	Mesozoic	Spring	Shinarump Mbr		Contact	36.948317453	-113.056328745							ADWR 2009b	
557	BLM-Legacy	LEG-241	2	Lost Spring; B-41-07 16CDD			Uinkaret Plateau - North	Mesozoic	Spring				36.94861	-113.05604	01-Jul-85	01-Jul-85	1.2	1.2	1.2	1	BLM 2010d	
557	NWIS-2	365654113032001	3	B-41-07 16CDD			Uinkaret Plateau - North	Mesozoic	Spring	Shinarump Mbr			36.94831779	-113.0563283							USGS 2010b	
557	NURE	GCAD503R	4				Uinkaret Plateau - North	Mesozoic	Spring	TRSS Ss			36.948384455	-113.056372748							USGS 2009b	
558	NURE	GCAD513R					Uinkaret Plateau - North	Mesozoic	Spring				36.931184475	-113.123975451							USGS 2009b	
559	BLM-Legacy	LEG-245		Lytle Spring; B-41-08 29CD			Uinkaret Plateau - North	Mesozoic	Spring				36.91897	-113.185	01-Jul-85	01-Jul-85	0.4	0.4	0.4	1	BLM 2010d	Spring Flow is .04 Gallons per Minute
560	BLM-Legacy	LEG-243		Upper Lytle Spring; B-41-09 25ACA			Uinkaret Plateau - North	Mesozoic	Spring				36.92798	-113.21443	01-Jul-85	01-Jul-85	0.19	0.19	0.19	1	BLM 2010d	Flow is .019 Gallons per Minute/Barely a Seep
561	BLM-Legacy	LEG-244		Wells Spring; B-41-08 11DDB			Uinkaret Plateau - North	Mesozoic	Spring				36.96393	-113.12226	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	

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Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
562	BLM-Legacy	LEG-246		Cottonwood Spring; B-41-09 25BA			Uinkaret Plateau - North	Mesozoic	Spring				36.9321	-113.21923	01-Jul-85	01-Jul-85	15	15	15	1	BLM 2010d	
563	GCWC-02-Map	M-133		B-42-07 31B			Uinkaret Plateau - North	Mesozoic	Spring				36.99911	-113.0997							Grand Canyon Wildlands Council 2002	
564	GWSI-1	362038113090101	1	Little Spring; B-34-08 16DAC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows		Contact	36.343870153	-113.151043857	16-Aug-50	10-Aug-76	2	2	2	1	ADWR 2009b	
564	NWIS-2	362038113090101	2	B-34-08 16DAC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows			36.34387004	-113.1510436							USGS 2010b	
564	BLM-Legacy	LEG-26	3	Little Spring; B-34-08 16DBD			Uinkaret Plateau - South	Mesozoic	Spring				36.34383	-113.15127	01-Jul-85	01-Jul-85	1	1	1	1	BLM 2010d	Also Known As Little Oak Spring
565	GWSI-1	362014113112501	1	Big Spring; B-34-08 19ABC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows	Perennial	Contact	36.337203071	-113.191045475							ADWR 2009b	
565	NWIS-2	362014113112501	2	B-34-08 19ABC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows			36.3372033	-113.1910453	07-Aug-51	10-Aug-76	2	2	2	1	USGS 2010b	
565	BLM-Legacy	LEG-27	3	Big Springs; B-34-08 19ABD			Uinkaret Plateau - South	Mesozoic	Spring				36.33694	-113.19096							BLM 2010d	
565	NURE	GCCD502R	4				Uinkaret Plateau - South	Mesozoic	Spring	UNKN Volcanics -Mafic			36.335681071	-113.190567408							USGS 2009b	
566	GCWC-02	BLM 179	1	Death Valley Spring; B-34-09 04DB			Uinkaret Plateau - South	Mesozoic	Spring	Qal alluvial deposits		Unknown; contact?	36.37306	-113.26194	19-Jun-00	19-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, Sawmill Mountains, 6 Miles Southwest of Mt. Trumbull
566	BLM-Legacy	LEG-33	2	Death Valley Spring; B-34-09 04DB			Uinkaret Plateau - South	Mesozoic	Spring				36.37306	-113.26194							BLM 2010d	Pipeline Broken
566	NURE	GCCC503R	3				Uinkaret Plateau - South	Mesozoic	Spring	KBBL Carbonate			36.373581039	-113.261571561							USGS 2009b	
567	GCWC-02	BLM 180	1	Cold Spring; B-34-09 09CDA			Uinkaret Plateau - South	Mesozoic	Spring	Basalt	Perennial	Fracture	36.35693	-113.26422	19-Jun-00	19-Jun-00	0.25	0.25	0.25	1	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, South Slope of Sawmill Mountains, 6.5 Miles Southwest of Mt. Trumbull
567	BLM-Legacy	LEG-30	2	Cold Spring; B-34-09 09CDA			Uinkaret Plateau - South	Mesozoic	Spring				36.35693	-113.26422	01-Jul-85	01-Jul-85	0.4	0.4	0.4	1	BLM 2010d	Unmaintained for Years
568	GCWC-02	BLM 600		Mount Trumbull Basalt Spring; B-34-08 04BB			Uinkaret Plateau - South	Mesozoic	Spring	Basalt	Ephemeral	Fracture	36.37893	-113.16181	20-Jun-00	20-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, One Mile South of Mt. Trumbull Administrative Site Abutting a Basalt Flow
569	BLM-Legacy	LEG-29		Lava Spring; B-34-08 04BBA			Uinkaret Plateau - South	Mesozoic	Spring				36.38089	-113.16097							BLM 2010d	Emerges at Base of a Recent Basalt Flow/Full Grown Mountain Lion Seen at Spring
570	BLM-Legacy	LEG-32		Randall Spring; B-34-09 13BD			Uinkaret Plateau - South	Mesozoic	Spring				36.3479	-113.21171							BLM 2010d	
571	BLM-Legacy	LEG-31		Sawmill Tank Spring; B-34-09 12BB			Uinkaret Plateau - South	Mesozoic	Spring				36.36762	-113.21478	01-Jul-85	01-Jul-85	0	0	0	1	BLM 2010d	Water is Also Piped from Tank to Private Land Approximately 1 Mile/ No Information on Exact Location/Jdr# to It is 4959
572	GCWC-02-Map	M-179		Whitmore Spring (historical); B-34-09 23CB			Uinkaret Plateau - South	Mesozoic	Spring				36.33154	-113.23359							Grand Canyon Wildlands Council 2002	
573	NURE	CDDC503R					Virgin River Valley	Mesozoic	Spring	CHNL Sh			37.008383093	-113.412784061							USGS 2009b	
574	BLM-Legacy	LEG-175		Mokaac Spring; B-40-12 04AE			Virgin River Valley	Mesozoic	Spring				36.89889	-113.58257	01-Jul-85	01-Jul-85	4.2	4.2	4.2	1	BLM 2010d	Additional Jdrs:4681,4973// Additional Uses:40,12,3,Sw nw/40,12,3,Senw/41,12,26, Nenw/41,12,23,Nene
575	BLM-Legacy	LEG-204	1	Lizard Spring West; B-41-12 28BB			Virgin River Valley	Mesozoic	Spring				36.92903	-113.60824	01-Jul-85	01-Jul-85	3.4	3.4	3.4	1	BLM 2010d	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
575	BLM-Legacy	LEG-206	2	Lizard Spring East; B-41-12 28BB			Virgin River Valley	Mesozoic	Spring				36.92903	-113.60824	05-Apr-85	05-Apr-85	3	3	3	1	BLM 2010d	No Sample Taken/Cement Troughs Still in Existence? Sampled 08-16-89 By Dme. Piped to Tank About 1 Mile to Ne. Seep Has Emerged Between 1985 and 1989 About 60 Feet Sw of De
576	GCWC-02	BLM 147	1	Oak Spring; B-39-12 04AB			Wolf Hole Mountain Vicinity	Mesozoic	Spring	Moenkopi Fm	Ephemeral	Contact	36.81695	-113.58645	21-Jun-00	21-Jun-00	0.02	0.02	0.02	1	Grand Canyon Wildlands Council 2002	Northwestern Az Strip, East of Wolf Hole Mountain, 1.5 Miles West of Quail Hill
576	BLM-Legacy	LEG-105	2	Oak Spring; B-39-12 04AB			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.81695	-113.58645	06-Jun-85	06-Jun-85	0.1	0.1	0.1	1	BLM 2010d	
577	BLM-Legacy	LEG-106		Wolf Hole Spring; B-39-12 21BD			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.76805	-113.5939	03-Jun-88	03-Jun-88	0.7	0.7	0.7	1	BLM 2010d	
578	BLM-Legacy	LEG-103		Tombstone Spring; B-39-12 30BA			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.75694	-113.6282	01-Aug-86	01-Aug-86	0.1	0.1	0.1	1	BLM 2010d	Dry During Droughty Years.
579	BLM-Legacy	LEG-173		Quail Spring; B-40-12 33AA			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.83186	-113.58275							BLM 2010d	Additional Jdrs:4427-Future Plans to Extned Pipeline Thru Sec 16 to Reservoir at Nwnw 15 (to Fill W/Unused Spring Water)/Pond and Old Wooden Collection Box at Source/Use #2
580	BLM-Legacy	LEG-170		Canyon Spring; B-40-11 17BD			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.86845	-113.50252	01-Jul-85	01-Jul-85	2	2	2	1	BLM 2010d	
581	BLM-Legacy	LEG-168		Seep Spring; B-40-11 17CA			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.86711	-113.5015	01-Jul-85	01-Jul-85	0.8	0.8	0.8	1	BLM 2010d	Two Troughs and Overflow Into Dirt Tanks
582	BLM-Legacy	LEG-172		Seegmiller Spring; B-40-11 17DD			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.86141	-113.49514	01-Jul-85	01-Jul-85	1	1	1	1	BLM 2010d	Large Storage Tank
583	BLM-Legacy	LEG-167		Clay Spring; B-40-11 33DB			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.82417	-113.47859							BLM 2010d	Large Storage Tank
584	GCWC-02-Map	M-77		B-40-11 33DA			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.82249	-113.47762							Grand Canyon Wildlands Council 2002	
585	BLM-Legacy	LEG-169		Old Canyon Seep; B-40-11 17DB			Wolf Hole Mountain Vicinity	Mesozoic	Spring				36.86989	-113.50353							BLM 2010d	
795	NURE	23077					Coconino Plateau - East	Perched	Spring				35.950185077	-112.524236512							USGS 2009b	
796	NWIS-2	355032113064701	1	Upper Pine Spring; B-28-08 32ADA			Coconino Plateau - West	Perched	Spring	Quaternary Alluvium			35.8422095	-113.1138136							USGS 2010b	
796	Wenrich-94	10A-W82	2	Upper Pine Spring			Coconino Plateau - West	Perched	Spring	Kaibab Ls			35.841931713	-113.114091323							Wenrich et al. 1994	
797	Wenrich-94	34A+B-W82	1	Hockey Puck Spring; B-30-08 31DCD			Coconino Plateau - West	Perched	Spring	Hermit Sh - Coconino Ss		Contact	35.933596715	-113.176038225							Wenrich et al. 1994	
797	NWIS-2	355602113103200	2	B-30-08 31DCD			Coconino Plateau - West	Perched	Spring	Coconino Ss			35.9338745	-113.176316							USGS 2010b	
797	NURE	23021	3				Coconino Plateau - West	Perched	Spring				35.933885613	-113.17676045							USGS 2009b	
798	NWIS-2	355959113122700	1	Big Spring; B-30-09 11 UNSURVEYED			Coconino Plateau - West	Perched	Spring	Toroweap Fm			35.99970668	-113.2082618	20-May-93	20-May-93	4.488312	4.488312	4.488312	1	USGS 2010b	
798	Wenrich-94	37A-W82	2	Big Spring			Coconino Plateau - West	Perched	Spring	Coconino Ss			35.999706654	-113.207428431							Wenrich et al. 1994	
799	NWIS-2	360435113104700	1	Beecher Spring; B-31-08 18BAD			Coconino Plateau - West	Perched	Spring	Hermit Sh			36.0763721	-113.1804841	20-May-93	20-May-93	0	0	0	1	USGS 2010b	
799	Wenrich-94	30A+B-W82	2	Beecher Spring			Coconino Plateau - West	Perched	Spring	Hermit Sh - Esplanade Ss		Contact	36.076094311	-113.17881745							Wenrich et al. 1994	
800	GWSI-1	355013113055201	1	Pine Springs; B-28-08 02DDB			Coconino Plateau - West	Perched	Spring				35.836931375	-113.098535487							ADWR 2009b	
800	Wenrich-94	12A-W82	2	Pine Spring; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Spring	Tertiary gravel			35.83665408	-113.098535287							Wenrich et al. 1994	
801	Wenrich-94	15A-W82	1	Pocomate Springs			Coconino Plateau - West	Perched	Spring	Coconino Ss			35.82193229	-113.161592833							Wenrich et al. 1994	
801	NURE	23172	2				Coconino Plateau - West	Perched	Spring				35.82238788	-113.161559533							USGS 2009b	

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Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
802	Wenrich-94	11A-W82		Unnamed spring 1/3 mile from Pine Tank			Coconino Plateau - West	Perched	Spring	Kaibab Ls			35.839709529	-113.103813273							Wenrich et al. 1994	
803	Wenrich-94	35A-W82		Red Spring			Coconino Plateau - West	Perched	Spring	Coconino Ss			36.070538166	-113.023811786							Wenrich et al. 1994	
804	Wenrich-94	36A-W82		Moss Spring			Coconino Plateau - West	Perched	Spring	Coconino Ss			36.061649367	-113.027700641							Wenrich et al. 1994	
805	Wenrich-94	8A-W82		Pocomate Springs			Coconino Plateau - West	Perched	Spring	Coconino Ss			35.823598952	-113.160481702							Wenrich et al. 1994	
806	NWIS-2	360744112595101		B-32-07 26DBA			Grand Canyon - Central	Perched	Spring	Supai Fm			36.12887086	-112.9982558							USGS 2010b	
807	NWIS-2	360733113035800	1	Cement Tank Spring; B-32-07 30DAD			Grand Canyon - Central	Perched	Spring	Supai Fm			36.1258155	-113.0668694	20-May-93	20-May-93	0	0	0	1	USGS 2010b	
807	NURE	GCDD501R	2				Grand Canyon - Central	Perched	Spring	CCNN Ss (perched)			36.125982185	-113.06725835							USGS 2009b	
808	GWSI-1	361345113031701	1	Saddle Horse Spring; B-33-07 28C			Grand Canyon - Central	Perched	Spring	Supai Fm	Perennial	Contact	36.2291481	-113.05548098							ADWR 2009b	
808	NWIS-2	361345113031701	2	B-33-07 28C UNSURVEYED			Grand Canyon - Central	Perched	Spring	Supai Fm			36.22914777	-113.0554812	09-Aug-76	09-Aug-76	1	1	1	1	USGS 2010b	
808	NWIS-1	361344113032001	3	Saddle Horse Spring			Grand Canyon - Central	Perched	Spring				36.22888889	-113.05555556							USGS 2009a	
808	GCWC-02	GCNP-1	4	Saddle Horse Spring (South); B-33-07 28CB			Grand Canyon - Central	Perched	Spring	Esplanade Ss	Perennial	Contact	36.22867	-113.05551	20-Jun-00	15-Aug-01	0.05	0.05	0.05	2	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau Area, One Mile North of Toroweap Overlook in Saddle Horse Canyon
809	NWIS-2	361237113025700		Honga Above the Mouth; B-33-07 33 UNSURVEYED			Grand Canyon - Central	Perched	Spring	Supai Fm			36.21025907	-113.0499252	02-Jul-93	10-Oct-93	2.244156	4.488312	3.366234	2	USGS 2010b	
810	Wenrich-94	29A-W82		Hells Hollow Spring			Grand Canyon - Central	Perched	Spring	Esplanade Ss			36.144982092	-113.109926891							Wenrich et al. 1994	
811	Wenrich-94	49A-W82		Horsehair Spring			Grand Canyon - Central	Perched	Spring	Wescogame Fm			36.156926608	-112.915753276							Wenrich et al. 1994	
812	GCWC-02	GCNP-2		Saddle Horse Spring (North); B-33-07 28BC			Grand Canyon - Central	Perched	Spring	Esplanade Ss	Ephemeral	Fracture	36.23439	-113.05682	20-Jun-00	20-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau Area, 1.25 Miles North of Toroweap Overlook in Saddle Horse Canyon
813	GCWC-02-Map	M-307		Jewell Spring; B-35-04 36A			Grand Canyon - Central	Perched	Spring				36.39354	-112.66522							Grand Canyon Wildlands Council 2002	
814	GCWC-02-Map	M-10		Cork Spring; B-34-05 26AD			Grand Canyon - Central	Perched	Spring				36.32014	-112.7912							Grand Canyon Wildlands Council 2002	
815	GWSI-1	361221112034001	1	Cliff Dweller Spring; A-32-03 03A			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls	Perennial		36.205815586	-112.061835595	01-Jun-75	01-Jun-76	2.2	3.1	2.65	2	ADWR 2009b	
815	NWIS-2	361221112034001	2	A-32-03 03A UNSURVEYED			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls			36.2058159	-112.0618357							USGS 2010b	
815	GCNP-1	TRAN003	3	Cliff Dweller Spring			Grand Canyon - North Rim	Perched	Spring	Kaibab LS/ Toroweap			36.205815586	-112.061835595	09-Jul-08	09-Jul-08	3	3	3	1	Grand Canyon National Park 2010a	
815	GCWC-02-Map	M-213	4	Cliff Dweller Spring; A-32.5-03 34			Grand Canyon - North Rim	Perched	Spring				36.20566	-112.06155							Grand Canyon Wildlands Council 2002	
816	GWSI-1	361302112040501	1	Sprayfield Spring; A-33-03 34B			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls			36.217204457	-112.06878091	01-Jun-75	01-Jun-75	8	8	8	1	ADWR 2009b	
816	NWIS-2	361302112040501	2	A-33-03 34B UNSURVEYED			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls			36.21720468	-112.0687805							USGS 2010b	
817	GCWC-02	GCNP-18	1	South Big Spring; A-34-01 26AC			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Perennial	Contact	36.31821	-112.26083	06-Aug-00	06-Aug-00	0.18	0.18	0.18	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of Big Springs Canyon near Lancelot Point, This is the Down Canyon Spring
817	GWSI-1	361906112153701	2	South Big Spring; A-34-01 26A			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm			36.318314241	-112.26100856	01-Jun-75	01-Jun-75	9	9	9	1	ADWR 2009b	

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817	NWIS-2	361906112153701	3	A-34-01 26A UNSURVEYED			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm			36.31831457	-112.2610083							USGS 2010b	
818	GCNP-1	BRIG009	1	Greenland Spring; A-33-04 19AD			Grand Canyon - North Rim	Perched	Spring	Coconino SS			36.244275727	-112.001766903	10-Jul-08	10-Jul-08	0	0	0	1	Grand Canyon National Park 2010a	
818	GCWC-02-Map	M-233	2	Greenland Spring; A-33-04 19AD			Grand Canyon - North Rim	Perched	Spring				36.24426	-112.00156							Grand Canyon Wildlands Council 2002	
819	GCWC-02-Map	M-211	1	Cliff Spring; A-32-04 27			Grand Canyon - North Rim	Perched	Spring				36.12441	-111.95312							Grand Canyon Wildlands Council 2002	
819	GCNP-1	CLIF001	2	Cliff Spring			Grand Canyon - North Rim	Perched	Spring	Kaibab/ Toroweap contact			36.125120798	-111.954345074	10-Jul-08	10-Jul-08	0.5	0.5	0.5	1	Grand Canyon National Park 2010a	
820	GCWC-02-Map	M-230	1	Bright Angel Spring; A-33-03 34BA			Grand Canyon - North Rim	Perched	Spring				36.2203	-112.06774							Grand Canyon Wildlands Council 2002	
820	GCNP-1	TRAN002	2	Bright Angel Spring			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm			36.219255277	-112.068836166	10-Jul-08	10-Jul-08	0	0	0	1	Grand Canyon National Park 2010a	
821	GCNP-1	WALL002		Wall Creek at Source			Grand Canyon - North Rim	Perched	Spring	Muav LS			36.165319548	-112.023197507							Grand Canyon National Park 2010a	
822	GCWC-02	GCNP-19		Middle Big Spring; A-34-01 26AC			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Perennial	Contact	36.31862	-112.2595	06-Aug-00	06-Aug-00	0.19	0.19	0.19	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of Big Springs Canyon near Lancelot Point, This is the Mid Canyon Spring
823	GCWC-02	GCNP-20		North Big Spring; A-34-01 26AA			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Ephemeral	Contact	36.32161	-112.2539	06-Aug-00	06-Aug-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of Big Springs Canyon near Lancelot Point, This is the Up Canyon Spring
824	GCWC-02	GCNP-6		Cliff Spring; A-32-04 27C			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Perennial	Contact	36.125	-111.93333	03-Aug-00	19-Jun-01	0.47	0.58	0.525	2	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Approximately 1 Mile North of Cape Royal Parking Lot. Road Sign Identifies 1/4 Mile Trail to Spring
825	GCWC-02-Map	M-19		Cougar Spring?; B-33-01 03			Grand Canyon - North Rim	Perched	Spring				36.29068	-112.3792							Grand Canyon Wildlands Council 2002	
826	GCWC-02-Map	M-106		B-34-01 24BDD			Grand Canyon - North Rim	Perched	Spring				36.33235	-112.35147							Grand Canyon Wildlands Council 2002	
827	GCWC-02-Map	M-107		B-34-01 24ACC			Grand Canyon - North Rim	Perched	Spring				36.33062	-112.34922							Grand Canyon Wildlands Council 2002	
828	GCWC-02-Map	M-248		Powell Spring; B-34-01 13BCC			Grand Canyon - North Rim	Perched	Spring				36.34567	-112.3578							Grand Canyon Wildlands Council 2002	
829	GCWC-02-Map	M-249		B-34-01 34			Grand Canyon - North Rim	Perched	Spring				36.30091	-112.38583							Grand Canyon Wildlands Council 2002	No Spring on Topo
830	NURE	23002	1	Amos Spring; B-30-12 36DC			Grand Canyon - West	Perched	Spring				35.941386754	-113.527271165							USGS 2009b	
830	GCWC-02-Map	M-186	2	Amos Spring; B-30-12 36DC			Grand Canyon - West	Perched	Spring				35.93984	-113.52628							Grand Canyon Wildlands Council 2002	
831	GCWC-02-Map	M-113		B-30-11 32B			Grand Canyon - West	Perched	Spring				35.9596	-113.49452							Grand Canyon Wildlands Council 2002	
832	GCWC-02-Map	M-15		Cottonwood Spring; B-30-12 13CA			Grand Canyon - West	Perched	Spring				35.9874	-113.52899							Grand Canyon Wildlands Council 2002	

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833	GCWC-02-Map	M-66		Mathis Spring; B-31-12 20C			Grand Canyon - West	Perched	Spring				36.06475	-113.60327							Grand Canyon Wildlands Council 2002	
834	GCWC-02-Map	M-169		Suicide Spring; B-30.5-12 36C			Grand Canyon - West	Perched	Spring				36.02862	-113.53209							Grand Canyon Wildlands Council 2002	
835	GCWC-02-Map	M-194		Lower Spring; B-31-12 16AA			Grand Canyon - West	Perched	Spring				36.09245	-113.5725							Grand Canyon Wildlands Council 2002	
836	GCWC-02-Map	M-202		Middle Spring; B-32-10 26BB			Grand Canyon - West	Perched	Spring				36.14833	-113.3373							Grand Canyon Wildlands Council 2002	
837	GCWC-02-Map	M-203		End Spring; B-32-10 27BD			Grand Canyon - West	Perched	Spring				36.14457	-113.35127							Grand Canyon Wildlands Council 2002	
838	GCWC-02-Map	M-35		George Spring; B-32-10 23BA			Grand Canyon - West	Perched	Spring				36.16508	-113.33148							Grand Canyon Wildlands Council 2002	
839	GCWC-02-Map	M-201		Frog Spring; B-32-10 13DD			Grand Canyon - West	Perched	Spring				36.16691	-113.30692							Grand Canyon Wildlands Council 2002	
840	BLM-Legacy	LEG-15		Shultz Spring; B-32-09 18B			Grand Canyon - West	Perched	Spring				36.17508	-113.30171	01-Jul-85	01-Jul-85	5	5	5	1	BLM 2010d	Approximately 10 Pools,1' × 3'/Another Source is Located in Wash Bottom and Surfaces in 2-3 Places/Unique Variety of Vegetation:Ash,Red Bud,Alder,Locust,Etc./ Spring Source See
841	GCWC-02-Map	M-198		Dripping Spring; B-32-10 20B			Grand Canyon - West	Perched	Spring				36.16145	-113.38696							Grand Canyon Wildlands Council 2002	
842	GCWC-02-Map	M-204		Lost Spring; B-32-10 20DA			Grand Canyon - West	Perched	Spring				36.15583	-113.37742							Grand Canyon Wildlands Council 2002	
843	GCWC-02-Map	M-216		Cupe Spring; B-33-10 27BD			Grand Canyon - West	Perched	Spring				36.23259	-113.33474							Grand Canyon Wildlands Council 2002	
844	GCWC-02-Map	M-188		B-30-11 31			Grand Canyon - West	Perched	Spring				35.95131	-113.50724							Grand Canyon Wildlands Council 2002	
845	GCWC-02	KNF-17		Sowats Spring A; B-36-02 12DB			Jumpup Canyon	Perched	Spring	Toroweap Fm	Perennial	Contact	36.53101	-112.45519	01-Jul-00	01-Jul-00	0.22	0.22	0.22	1	Grand Canyon Wildlands Council 2002	Southern Kanab Plateau, East Side, North of Kwagant Hollow, Spring is Up Big Sowats Canyon from the Trail
846	GCWC-02	KNF-18		Sowats Spring B; B-36-02 12DC			Jumpup Canyon	Perched	Spring	Toroweap Fm	Perennial	Contact	36.52783	-112.45501	01-Jul-00	01-Jul-00	1.48	1.48	1.48	1	Grand Canyon Wildlands Council 2002	Southern Kanab Plateau, East Side, North of Kwagant Hollow, Spring is Down Big Sowats Canyon from Where the Trail Ends in the Bottom of the Canyon, and on the Eastern Slope.
847	GCWC-02	KNF-19		Sowats Spring; B-36-02 13AA			Jumpup Canyon	Perched	Spring	Toroweap Fm	Perennial	Contact	36.52443	-112.45532	01-Jul-00	01-Jul-00	3.79	3.79	3.79	1	Grand Canyon Wildlands Council 2002	Southern Kanab Plateau, East Side, North of Kwagant Hollow, Spring is Down Big Sowats Canyon from Where the Trail Ends in the Bottom of the Canyon, and on the Eastern Slope
848	GCWC-02-Map	M-122		White Spring; B-36-02 04D			Jumpup Canyon	Perched	Spring				36.54456	-112.50781							Grand Canyon Wildlands Council 2002	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
849	GCWC-02-Map	M-29		East Box Elder Spring; B-36-02 03D			Jumpup Canyon	Perched	Spring				36.54603	-112.49281							Grand Canyon Wildlands Council 2002	
850	GCWC-02-Map	M-173		Upper Cottonwood Spring; B-36-02 17D			Jumpup Canyon	Perched	Spring				36.51811	-112.52331							Grand Canyon Wildlands Council 2002	
851	Springs_0103	WHITE		White Spring			Jumpup Canyon	Perched	Spring				36.5429511725	-112.526867274							BLM 2010c	
852	GCWC-02	GCNP-17	1	Kanabownits Spring; A-33-02 05BC			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact; Fault?	36.28682	-112.21295	06-Aug-00	22-Jun-01	0	10.2	5.1	2	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Kanabownits Canyon Adjacent to Widforss Point Road, Three Miles West of Crystal Creek
852	GWSI-1	361714112124601	2	Kanabownits Spring; A-33-02 05B			Kaibab Plateau	Perched	Spring	Toroweap Fm			36.287203074	-112.213507063	01-Jun-75	01-Jun-76	5	10	7.5	2	ADWR 2009b	
852	NWIS-2	361714112124601	3	A-33-02 05B UNSURVEYED			Kaibab Plateau	Perched	Spring	Toroweap Fm			36.2872033	-112.2135068							USGS 2010b	
852	GCNP-1	KANB001	4	Kanabownits Spring			Kaibab Plateau	Perched	Spring	Alluvium			36.287327903	-112.213386216	09-Jul-08	07-Nov-08	0	0.625	0.3125	2	Grand Canyon National Park 2010a	
853	GCWC-02	GCNP-11	1	Robbers Roost Spring; A-33-03 04CC			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact; Fault?	36.28027	-112.08867	04-Aug-00	04-Aug-00	3.37	3.37	3.37	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of the Basin and Outlet Canyon Approximately Four and One Half Miles South of the Gcnp and Nknf Boundary and Off of Hwy 67
853	GWSI-1	361650112051601	2	Robber's Roost Spring; A-33-03 04C			Kaibab Plateau	Perched	Spring	Toroweap Fm			36.280538426	-112.088504195	01-Jun-75	01-Jun-76	12	13.25	12.625	2	ADWR 2009b	
853	NWIS-2	361650112051601	3	A-33-03 04C UNSURVEYED			Kaibab Plateau	Perched	Spring	Toroweap Fm			36.28053798	-112.088504							USGS 2010b	
853	GCNP-1	PHAN005	4	Robber's Roost			Kaibab Plateau	Perched	Spring	Toroweap Fm			36.280573673	-112.089067701	28-Oct-06	08-Jul-08	0	673	168.43625	4	Grand Canyon National Park 2010a	
853	NWIS-1	361650112052001	5	Robbers Roost Spring			Kaibab Plateau	Perched	Spring				36.28055556	-112.08888889							USGS 2009a	
854	GCWC-02-Map	M-229	1	Lower Thompson Spring; A-33-03 22AD			Kaibab Plateau	Perched	Spring				36.24331	-112.05897							Grand Canyon Wildlands Council 2002	
854	GWSI-1	361432112033201	2	Lower Thompson Spring; A-33-03 22D			Kaibab Plateau	Perched	Spring	Kaibab Ls			36.242204459	-112.05961401	01-Jun-75	01-Jun-76	0.25	0.3	0.275	2	ADWR 2009b	
854	NWIS-2	361432112033201	3	A-33-03 22D UNSURVEYED			Kaibab Plateau	Perched	Spring	Kaibab Ls			36.24220468	-112.0596139							USGS 2010b	
855	GCWC-02	GCNP-22	1	Tipover Spring; A-34-02 18AC			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact	36.34738	-112.22354	07-Aug-00	07-Aug-00	0.15	0.15	0.15	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Big Springs Canyon, 0.5 Miles South of Swamp Ridge Road
855	GWSI-1	362046112132101	2	Tipover Spring; A-34-02 18A			Kaibab Plateau	Perched	Spring	Toroweap Fm			36.346092993	-112.223229868	01-Jun-75	01-Jun-76	0.25	0.7	0.475	2	ADWR 2009b	
855	NWIS-2	362046112132101	3	A-34-02 18A UNSURVEYED			Kaibab Plateau	Perched	Spring	Toroweap Fm			36.3460931	-112.2232299							USGS 2010b	
856	GWSI-1	363720112202201	1	Mangum Spring; A-37-01 07BCB			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact	36.622209393	-112.340180931							ADWR 2009b	
856	NWIS-2	363720112202201	2	A-37-01 07BCB			Kaibab Plateau	Perched	Spring	Coconino Ss			36.6222096	-112.3401814	08-Aug-76	08-Aug-76	25	25	25	1	USGS 2010b	
856	GCWC-02-Map	M-119	3	Mangum Springs B; A-37-01 07BC			Kaibab Plateau	Perched	Spring				36.62255	-112.33971							Grand Canyon Wildlands Council 2002	
857	GWSI-1	363607112205201	1	Big Spring; B-37-01 13DCB			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact	36.601930826	-112.348514901							ADWR 2009b	
857	NWIS-2	363607112205201	2	B-37-01 13DCB			Kaibab Plateau	Perched	Spring	Coconino Ss			36.60193127	-112.3485147	08-Aug-76	08-Aug-76	50	50	50	1	USGS 2010b	
857	GCWC-02	KNF-22	3	Big Springs; B-37-01 13DC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact; Fault	36.60227	-112.34854	02-Jul-00	22-Jun-01	195	195	195	2	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, Big Springs Canyon, at Big Springs Administrative Site
857	NURE	GCBG501R	4				Kaibab Plateau	Perched	Spring	UNKN Ss			36.602286839	-112.348436904							USGS 2009b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
858	GCWC-02	GCNP-8	1	Neal Spring; A-33-04 18DA			Kaibab Plateau	Perched	Spring	Toroweap Fm		Unknown; contact?	36.25701	-112.00293	03-Aug-00	03-Aug-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Intersection of Cape Royal Road and Point Imperial Road, in Bright Angel Creek
858	GCNP-1	BRIG010	2	Neal Spring			Kaibab Plateau	Perched	Spring				36.256903164	-112.003174793	03-Jun-08	03-Jun-08	0.01	0.01	0.01	1	Grand Canyon National Park 2010a	
859	GCNP-1	OUTL002	1	Outlet Spring; B-33-03 29CA			Kaibab Plateau	Perched	Spring	Toroweap/ Kaibab			36.228033951	-112.100878682	08-Jul-08	08-Jul-08	3	3	3	1	Grand Canyon National Park 2010a	
859	GCWC-02-Map	M-232	2	Outlet Spring; B-33-03 29CA			Kaibab Plateau	Perched	Spring				36.22774	-112.10119							Grand Canyon Wildlands Council 2002	
860	GCWC-02	GCNP-9	1	Upper Thompson Spring; A-33-03 14BC			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact	36.25937	-112.0558	03-Aug-00	03-Aug-00	0.12	0.12	0.12	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, in Thompson Canyon, Eight Miles South of the Gcnp and Nknf Boundary Off of Hwy 67
860	GCNP-1	THOM001	2	Upper Thompson Spring			Kaibab Plateau	Perched	Spring	Kaibab LS			36.259243994	-112.055900682	10-Jul-08	10-Jul-08	0.1	0.1	0.1	1	Grand Canyon National Park 2010a	
861	GCWC-02-Map	M-118	1	Mangum Springs A; B-37-01 12AA			Kaibab Plateau	Perched	Spring				36.62554	-112.34509							Grand Canyon Wildlands Council 2002	
861	NURE	GCBG502R	2				Kaibab Plateau	Perched	Spring	UNKN Ss			36.625087425	-112.345837194							USGS 2009b	
862	GCWC-02	KNF-21	1	Castle Spring; A-37-01 19CC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact; Fracture	36.58626	-112.34168	02-Jul-00	02-Jul-00	3.8	3.8	3.8	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Castle Canyon, One Mile South of Big Springs Administrative Site
862	NURE	GCBG504R	2				Kaibab Plateau	Perched	Spring	UNKN Ss			36.585786472	-112.34183638							USGS 2009b	
863	GCWC-02	GCNP-13		Spring; A-33-03 20AA			Kaibab Plateau	Perched	Spring	Kaibab Ls	Ephemeral	Contact	36.25085	-112.0942	05-Aug-00	05-Aug-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, 3.2 Miles West of Hwy 67 on Widforss Point Road, Approximately One Mile South of the Basin
864	GCWC-02	GCNP-14		Basin Spring; A-33-03 08CC			Kaibab Plateau	Perched	Spring	Coconino Ss	Ephemeral	Contact; Fault?	36.26666	-112.10759	05-Aug-00	05-Aug-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Approximately Four Miles West of Hwy 67 Off of Widforss Point Road, in the Basin
865	GCWC-02	GCNP-16		Milk Creek Spring; A-33-02 12CB			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact	36.27097	-112.1438	05-Aug-00	05-Aug-00	1.61	1.61	1.61	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Approximately 7.5 Miles West of Hwy 67 Off of Widforss Point Road, in Milk Creek Approximately 3/4 Mile North of Widforss Point Road
866	GCWC-02	GCNP-5		No Name spring; A-33-03 26BB			Kaibab Plateau	Perched	Spring	Toroweap Fm		Contact	36.23396	-112.05162	02-Aug-00	02-Aug-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, on Cape Royal Road Approximately 0.4 Miles Northeast of Hwy 67
867	GCWC-02	KNF-101		Timp Spring; A-35-01 33DB			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact	36.38757	-112.2953	08-Aug-00	08-Aug-00	1.43	1.43	1.43	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Timp Canyon
868	GCWC-02	KNF-14		Parissawampitts Spring; A-35-01 20CC			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact	36.41305	-112.31705	30-Jun-00	30-Jun-00	0.44	0.44	0.44	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Parissawampitts Canyon
869	GCWC-02	KNF-15		Bee Spring; A-35-01 08BA			Kaibab Plateau	Perched	Spring	Kaibab Ls		Contact	36.4505	-112.31848	30-Jun-00	30-Jun-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Indian Hollow Canyon
870	GCWC-02	KNF-20		Mourning Dove Spring; B-37-01 12DC			Kaibab Plateau	Perched	Spring	Toroweap Fm		Contact	36.61659	-112.34795	02-Jul-00	02-Jul-00	0.82	0.82	0.82	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, Side Canyon to Big Springs Canyon, One Mile North of Big Springs Administrative Site

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
871	GCWC-02	KNF-11		Quaking Aspen Spring; A-34-01 03BA			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact	36.3801	-112.28334	29-Jun-00	29-Jun-00	2.06	2.06	2.06	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Quaking Aspen Canyon
872	GCWC-02	KNF-12		Watts Spring; A-34-01 03AB			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact	36.37971	-112.27575	29-Jun-00	29-Jun-00	1.2	1.2	1.2	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Quaking Aspen Canyon
873	GCWC-02-Map	M-62		Lower Two Spring; A-34-01 08			Kaibab Plateau	Perched	Spring				36.36639	-112.30713							Grand Canyon Wildlands Council 2002	
874	GCWC-02	KNF-100		Upper Two Spring; A-34-01 09BA			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact	36.36491	-112.29853	07-Aug-00	07-Aug-00	0	0	0	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Side Canyon to Lower Quaking Aspen Canyon
875	GCWC-02-Map	M-46		Ikes Spring; A-34-01 15			Kaibab Plateau	Perched	Spring				36.34863	-112.27214							Grand Canyon Wildlands Council 2002	
876	GCWC-02	KNF-13		Pasture Spring; A-34-01 04BD			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact; Fracture	36.37799	-112.29821	30-Jun-00	30-Jun-00	0.45	0.45	0.45	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Quaking Aspen Canyon
877	GCWC-02-Map	M-262		Bear Spring; A-34-02 03C			Kaibab Plateau	Perched	Spring				36.36995	-112.17542							Grand Canyon Wildlands Council 2002	
878	GCWC-02-Map	M-263		Fawn Spring; A-34-02 14DC			Kaibab Plateau	Perched	Spring				36.33792	-112.15145							Grand Canyon Wildlands Council 2002	
879	GCWC-02-Map	M-167		South Canyon Spring; A-34-03 13CCC			Kaibab Plateau	Perched	Spring				36.33809	-112.03745							Grand Canyon Wildlands Council 2002	
880	GCWC-02-Map	M-345		Mangum Springs C; A-37-01 07BC			Kaibab Plateau	Perched	Spring				36.62187	-112.33896							Grand Canyon Wildlands Council 2002	
881	GCWC-02-Map	M-152		Riggs Spring or Canyon??; A-37-01 31D			Kaibab Plateau	Perched	Spring				36.55987	-112.32671							Grand Canyon Wildlands Council 2002	
882	GCWC-02-Map	M-282		Crazy Jug Spring; B-35-01 14CB			Kaibab Plateau	Perched	Spring				36.43131	-112.37688							Grand Canyon Wildlands Council 2002	
883	GCWC-02-Map	M-281		Squaw Spring; A-35-01 34B			Kaibab Plateau	Perched	Spring				36.39511	-112.28521							Grand Canyon Wildlands Council 2002	
884	GCWC-02	KNF-3		Crystal Spring; A-35-03 32A			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact	36.39038	-112.09653	27-Jun-00	27-Jun-00	0.94	0.94	0.94	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, Approximately 2.5 Miles East of Kaibab Lodge and Hwy 67
885	GCWC-02-Map	M-304		North Canyon Spring; A-35-03 28CD			Kaibab Plateau	Perched	Spring				36.39708	-112.08355							Grand Canyon Wildlands Council 2002	
886	GCWC-02	KNF-5		North Canyon Spring upper; A-35-03 28BBB			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact	36.40992	-112.08963	28-Jun-00	28-Jun-00	0.93	0.93	0.93	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, the Head of and in North Canyon
887	GCWC-02	KNF-7		North Canyon Spring middle; A-35-03 28BDA			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact	36.40522	-112.08342	28-Jun-00	20-Jun-01	6.63	9.2	7.915	2	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, the Head of and in North Canyon
888	GCWC-02	KNF-6		North Canyon Spring lower; A-35-03 28DBC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact	36.40096	-112.08059	28-Jun-00	28-Jun-00	44	44	44	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, the Head of and in North Canyon
889	GCWC-02	KNF-6A		North Canyon Spring all; A-35-03 28CAC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact	36.39989	-112.08578	28-Jun-00	28-Jun-00	110.2	110.2	110.2	1	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, the Head of and in North Canyon
890	GCWC-02-Map	M-303		North Canyon Spring; A-35-03 28CDC			Kaibab Plateau	Perched	Spring				36.39617	-112.08493							Grand Canyon Wildlands Council 2002	
891	GCWC-02-Map	M-346		Mangum Springs; A-37-01 07BDD			Kaibab Plateau	Perched	Spring				36.62059	-112.33689							Grand Canyon Wildlands Council 2002	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
892	GCWC-02-Map	M-264		South Big Spring; A-34-02 16AA			Kaibab Plateau	Perched	Spring				36.35091	-112.18537							Grand Canyon Wildlands Council 2002	
893	GCWC-02-Map	M-147		Oquer Spring; A-36-01 13A			Kaibab Plateau	Perched	Spring				36.52398	-112.24191							Grand Canyon Wildlands Council 2002	
894	GCWC-02-Map	M-266		A-34-02 19			Kaibab Plateau	Perched	Spring				36.3305	-112.22603							Grand Canyon Wildlands Council 2002	
895	NHD-1	124574533					Little Colorado River	Perched	Spring				36.0945898106	-111.67512527							USGS 2007	
896	GWSI-1	361824113240801	1	Schutz Spring; B-34-10 31ABD			Shivwits Plateau	Perched	Spring	Basaltic Flows			36.306647401	-113.402993269							ADWR 2009b	
896	NWIS-2	361824113240801	2	B-34-10 31ABD			Shivwits Plateau	Perched	Spring				36.30664707	-113.4029935							USGS 2010b	
896	GCWC-02-Map	M-197	3	Schultz Spring; B-34-10 31AA			Shivwits Plateau	Perched	Spring				36.30626	-113.40316							Grand Canyon Wildlands Council 2002	
897	BLM-Legacy	LEG-4	1	Dansil Spring; B-32-11 10BA			Shivwits Plateau	Perched	Spring				36.19269	-113.45631	01-Jul-85	01-Jul-85	2	2	2	1	BLM 2010d	No State Water Rights Filing
897	Hopkins-84a	GW029W	2				Shivwits Plateau	Perched	Spring				36.192759251	-113.456324792							Hopkins et al. 1984a	
898	BLM-Legacy	LEG-5	1	Mud Spring; B-32-11 02CA			Shivwits Plateau	Perched	Spring				36.20107	-113.44021	01-Jul-85	01-Jul-85	0.2	0.2	0.2	1	BLM 2010d	No State Water Rights Filing
898	Hopkins-84a	GW030W	2				Shivwits Plateau	Perched	Spring				36.201092377	-113.440769014							Hopkins et al. 1984a	
899	GCWC-02	BLM 166	1	Grassy Spring; B-33-11 09CDD			Shivwits Plateau	Perched	Spring	Moenkopi Fm	Perennial	Contact	36.26727	-113.47855	17-Jun-00	17-Jun-00	0.1	0.1	0.1	1	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, Southwest and on Top of Grassy Mountain
899	BLM-Legacy	LEG-10	2	Grassy Spring; B-33-11 09CDD			Shivwits Plateau	Perched	Spring				36.26727	-113.47855	01-Jul-85	01-Jul-85	0.3	0.3	0.3	1	BLM 2010d	
899	NURE	GCCC502R	3				Shivwits Plateau	Perched	Spring	KBBL Carbonate			36.267480064	-113.478770437							USGS 2009b	
899	Hopkins-84a	GW034W	4				Shivwits Plateau	Perched	Spring				36.26720226	-113.479937137							Hopkins et al. 1984a	
900	GCWC-02	BLM 149	1	Hidden Spring; B-36-12 31CCC			Shivwits Plateau	Perched	Spring	Toroweap Fm - Hermit Sh	Perennial	Contact	36.46979	-113.62869	15-May-00	15-May-00	3.1	3.1	3.1	1	Grand Canyon Wildlands Council 2002	Western Az Strip, Hidden Rim Area, Hidden Canyon
900	BLM-Legacy	LEG-47	2	Hidden Spring; B-36-12 31CC			Shivwits Plateau	Perched	Spring				36.46979	-113.62869	01-Jul-85	01-Jul-85	5.3	5.3	5.3	1	BLM 2010d	Additional Jdr:4707// Additional Uses:36,12,31 ,Swsw/36,12,31,Nenw/36 ,12,30,Sese//Spring Fills Storage Which Services 2 Allotments
901	BLM-Legacy	LEG-7		Tungsten Spring; B-33-11 23AA			Shivwits Plateau	Perched	Spring				36.25093	-113.43504	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	Pipe and Trough Inoperative
902	GCWC-02-Map	M-59		Lower Hidden Spring; B-36-12 36DD			Shivwits Plateau	Perched	Spring				36.47278	-113.63439							Grand Canyon Wildlands Council 2002	
903	GCWC-02-Map	M-287		B-35-12 06			Shivwits Plateau	Perched	Spring				36.46327	-113.62038							Grand Canyon Wildlands Council 2002	
904	GCWC-02-Map	M-181		Willow Spring; B-34-06 32D			Tuckup Canyon	Perched	Spring				36.30157	-112.95598							Grand Canyon Wildlands Council 2002	
905	GCWC-02-Map	M-236		Dome Spring; B-33-06 01C			Tuckup Canyon	Perched	Spring				36.28335	-112.8934							Grand Canyon Wildlands Council 2002	
906	GCWC-02-Map	M-108		B-34-05 32C			Tuckup Canyon	Perched	Spring				36.30151	-112.8575							Grand Canyon Wildlands Council 2002	
907	GCWC-02-Map	M-237		Tule Spring; B-33-06 09ADD			Tuckup Canyon	Perched	Spring				36.27661	-112.93211							Grand Canyon Wildlands Council 2002	
908	GWSI-1	365348113191001	1	Ruesch Spring; B-40-10 01ACC			Uinkaret Plateau - North	Perched	Spring	Alluvium		Seepage of Filtration	36.896650778	-113.320226905	26-Sep-51	26-Sep-51	0.5	0.5	0.5	1	ADWR 2009b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
908	NWIS-2	365348113191001	2	B-40-10 01ACC			Uinkaret Plateau - North	Perched	Spring	Holocene Alluvium			36.89665045	-113.3202273							USGS 2010b	
909	GWSI-1	365637113143801	1	Antelope Spring; B-41-09 23BCB			Uinkaret Plateau - North	Perched	Spring	Moenkopi Fm		Seepage of Filtration	36.943595366	-113.24466958							ADWR 2009b	
909	BLM-Legacy	LEG-249	2	Antelope Spring; B-41-09 23BBC			Uinkaret Plateau - North	Perched	Spring				36.94387	-113.24456	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	
909	NWIS-2	365637113143801	3	B-41-09 23BCB			Uinkaret Plateau - North	Perched	Spring	Moenkopi Fm			36.94359548	-113.2446695							USGS 2010b	
910	NURE	GCAC503R					Uinkaret Plateau - North	Perched	Spring	KBBL Other			36.895183839	-113.313482722							USGS 2009b	
911	BLM-Legacy	LEG-251		Antelope Seeps South; B-41-09 23BBC			Uinkaret Plateau - North	Perched	Spring				36.94387	-113.24456	01-Jul-85	01-Jul-85	0.1	0.1	0.1	1	BLM 2010d	
912	BLM-Legacy	LEG-247		Antelope Seeps South-West; B-41-09 23BBC			Uinkaret Plateau - North	Perched	Spring				36.94387	-113.24456	01-Jul-85	01-Jul-85	0.1	0.1	0.1	1	BLM 2010d	
913	BLM-Legacy	LEG-242		Water Canyon Spring; B-41-07 07DC			Uinkaret Plateau - North	Perched	Spring				36.96437	-113.08743	01-Jul-85	01-Jul-85	0.5	0.5	0.5	1	BLM 2010d	
914	BLM-Legacy	LEG-200		Cottonwood Canyon Seeps; B-41-10 25AA			Uinkaret Plateau - North	Perched	Spring				36.93113	-113.31961	05-Aug-85	05-Aug-85	0.1	0.1	0.1	1	BLM 2010d	
915	BLM-Legacy	LEG-248		Cottonwood Canyon Spring; B-41-09 30BB			Uinkaret Plateau - North	Perched	Spring				36.93117	-113.31345	07-Sep-90	07-Sep-90	1	1	1	1	BLM 2010d	Wet Area is 2 to 15 Feet Wide and About 2000 Feet Long. Cottonwoods, Cattails, Sedges, Grasses, Ash.
916	BLM-Legacy	LEG-166		Ruesch Spring 1; B-40-10 01DB			Uinkaret Plateau - North	Perched	Spring				36.89514	-113.31854	01-Jan-79	01-Jan-79	0.6	0.6	0.6	1	BLM 2010d	Piped to Cement Dugout (Ferry Shrimp Habitat)
917	BLM-Legacy	LEG-250		Upper Antelope Spring; B-41-09 27ACD			Uinkaret Plateau - North	Perched	Spring				36.92723	-113.25087	01-Jul-85	01-Jul-85	0.7	0.7	0.7	1	BLM 2010d	Spring Flow is .07 Gallons per Minute
998	NWIS-2	361025113071100		Artesian Spring at River Mile 182; B-32-08 10 UNSURVEYED	182		Grand Canyon - Central	Regional	Spring	Muav Ls			36.17359288	-113.1204832	07-Nov-90	28-May-95	4.488312	170.555856	62.836368	3	USGS 2010b	
999	NWIS-2	360917113064200		B-32-08 14 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Redwall Ls			36.1547042	-113.112427							USGS 2010b	
1000	NWIS-2	360957113080200		B-32-08 22 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.1658152	-113.1346503	02-Jul-93	11-Oct-93	44.88312	89.76624	67.32468	2	USGS 2010b	
1001	GCWC-02	GCNP-112	1	Fern Glen; B-33-06 15A			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Contact	36.26244	-112.91944	05-Apr-01	05-Apr-01	2	2	2	1	Grand Canyon Wildlands Council 2002	in Fern Glen Canyon, Approximately 0.25 Miles from the Colorado River at River Mile 168
1001	GWSI-1	361543112550301	2	B-33-06 15A			Grand Canyon - Central	Regional	Spring	Muav Ls			36.261925552	-112.918254271							ADWR 2009b	
1001	NWIS-2	361543112550301	3	B-33-06 15A UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.261926	-112.9182543							USGS 2010b	
1001	Peterson-77	CF-14	4	Fern Glen Canyon; River Mile 168	168		Grand Canyon - Central	Regional	Spring	Muav Ls			36.261925953	-112.918254272	08-May-76	08-May-76	1	1	1	1	Peterson et al. 1977	
1001	Taylor-04	FERN	5	Fern Glen			Grand Canyon - Central	Regional	Spring	Muav Ls			36.2615965431	-112.9178228867							Taylor et al. 2004	Reported Location Utm (327710,4014470)
1002	NWIS-2	361310112580400		Mohawk Canyon; B-33-06 30 1 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.21942584	-112.9685333	09-Oct-93	06-Jan-95	8.976624	8.976624	8.976624	2	USGS 2010b	
1003	NWIS-2	361252112580901	1	Mohawk Spring; B-33-06 30 2 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.21442587	-112.9699222							USGS 2010b	
1003	Wenrich-94	50A-W82	2	Mohawk Spring			Grand Canyon - Central	Regional	Spring	Muav Ls			36.213037028	-112.971033376							Wenrich et al. 1994	
1004	NWIS-2	361148113045900		Warm Spring; B-33-08 31 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.1966481	-113.0838153	09-May-76	07-Jan-95	125.672736	6732.468	2066.867676	4	USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1005	STORET-1	GRCA_FIT_ MATK02	1	Matkatamiba Spring			Grand Canyon - Central	Regional	Spring	Redwall Ls		Contact; Fault	36.3245132	-112.6598047							USEPA 2010	Matkatamiba Spring Emerges from a Seam at the Contact Between Whitmore Wash and Thunder Spring Members of Redwall Limestone, in the Main Channel of Matkatamiba Canyon Immediately Downstream from the Sinyala Fault. the Site is Within the Boundary of Grand
1005	Fitz-96	MATK	2	Matkatamiba Spring			Grand Canyon - Central	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent		36.3245132	-112.6598047	01-Jan-94	01-Jan-94	1	1	1	1	Fitzgerald 1996	
1005	NWIS-2	361928112393201	3	B-34-03 30 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Redwall Ls			36.3244269	-112.6596347	21-Jan-02	05-May-02	4.488312	8.976624	6.732468	2	USGS 2010b	
1006	GWSI-1	362044112401501	1	B-34-04 13D			Grand Canyon - Central	Regional	Spring	Muav Ls			36.345538681	-112.671579542							ADWR 2009b	
1006	NWIS-2	362044112401501	2	B-34-04 13D UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.34553824	-112.6715799							USGS 2010b	
1006	Peterson-77	CF-10	3	River Mile 147.9	147.9		Grand Canyon - Central	Regional	Spring	Muav Ls			36.345538285	-112.671579843	07-May-76	07-May-76	2	2	2	1	Peterson et al. 1977	
1006	GCWC-02	GCNP-111	4	Mile 148 upper; B-34-04 13C			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Contact	36.34603	-112.67064	04-Apr-01	04-Apr-01	4.14	4.14	4.14	1	Grand Canyon Wildlands Council 2002	Colorado River Mile 147.8, Right Site at 25 Meters from River
1007	GWSI-1	362425112254601	1	Tapeats Spring; B-35-01 29B			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Tubular Cave	36.406926672	-112.430181362							ADWR 2009b	
1007	NWIS-2	362425112254601	2	B-35-01 29B UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.4069271	-112.4301818	27-Jun-51	27-Jun-51	16710	16710	16710	1	USGS 2010b	
1007	GCWC-02-Map	M-283	3	Tapeats Spring; B-35-01 29BB			Grand Canyon - Central	Regional	Spring				36.40638	-112.42988							Grand Canyon Wildlands Council 2002	
1008	GWSI-1	362346112272801	1	Thunder Spring; B-35-02 25D			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Tubular Cave	36.396093491	-112.458516308							ADWR 2009b	
1008	NWIS-2	362346112272801	2	B-35-02 25D UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.3960936	-112.458516	27-Jun-51	27-Jun-51	7392	7392	7392	1	USGS 2010b	
1008	GCWC-02-Map	M-184	3	Thunder Spring; B-35-02 25DCC			Grand Canyon - Central	Regional	Spring				36.39613	-112.4585							Grand Canyon Wildlands Council 2002	
1009	NWIS-2	361518112523901		B-36-06 24 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls			36.2549818	-112.8782527	06-Jan-95	06-Jan-95	67.32468	67.32468	67.32468	1	USGS 2010b	
1010	GCNP-1	COLO052		Beecher Spring			Grand Canyon - Central	Regional	Spring				36.167222222	-113.141388889							Grand Canyon National Park 2010a	
1011	GCWC-02	GCNP-108	1	Deer Creek upper falls; B-35-02 27C			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Fracture	36.39978	-112.50198	03-Apr-01	03-Apr-01	2485	2485	2485	1	Grand Canyon Wildlands Council 2002	in Deer Creek Canyon, Approximately 100 Meters from the Colorado River at River Mile 136.3 on Trail to Deer Canyon.
1011	GCNP-1	DEER003	2	Deer Creek Below Dutton Spring (waterfall source)			Grand Canyon - Central	Regional	Spring				36.3997222	-112.5019444	02-Apr-06	02-Apr-06	3001	3001	3001	1	Grand Canyon National Park 2010a	
1012	GCNP-1	DEER005		Deer Creek near Upper/Northern Source			Grand Canyon - Central	Regional	Spring	Muav-Bright Angel Sh			36.4013889	-112.5069444	16-Sep-05	02-Apr-06	1414	1461.88	1437.94	2	Grand Canyon National Park 2010a	
1013	GCNP-1	DEER007		Deer Creek middle source spring (calculated Q)			Grand Canyon - Central	Regional	Spring				36.4002777	-112.5063888	02-Apr-06	02-Apr-06	700.176672	700.176672	700.176672	1	Grand Canyon National Park 2010a	
1014	GCNP-1	DEER008		Deer Creek Dutton spring (calculated Q)			Grand Canyon - Central	Regional	Spring				36.4016666	-112.5063888	02-Apr-06	02-Apr-06	888.685776	888.685776	888.685776	1	Grand Canyon National Park 2010a	
1015	Wenrich-94	76A-W82	1	Lava Falls (by cliff)			Grand Canyon - Central	Regional	Spring	Muav Ls			36.196119529	-113.081302574							Wenrich et al. 1994	
1015	Peterson-77	CF-15	2	Lava Falls; River Mile 179.3	179.3		Grand Canyon - Central	Regional	Spring	Muav Ls			36.194148186	-113.083815345							Peterson et al. 1977	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1016	Taylor-04	COVE-CAN		Cove Canyon			Grand Canyon - Central	Regional	Spring	Muav Ls			36.2456687725	-113.0152019877							Taylor et al. 2004	Reported Location Utm (318924,4012881)
1017	Taylor-04	KEYHOLE		Keyhole Spring			Grand Canyon - Central	Regional	Spring	Muav Ls			36.3795569166	-112.5823642888							Taylor et al. 2004	Reported Location Utm (358063,4027010)
1018	Taylor-04	MOHAWK-CAN		Mohawk Canyon			Grand Canyon - Central	Regional	Spring	Muav Ls			36.2246357352	-112.9672819154							Taylor et al. 2004	Reported Location Utm (323183,4010459)
1019	Taylor-04	RM147_SE		River Mile 147 Seep	147		Grand Canyon - Central	Regional	Spring	Muav Ls			36.3430506179	-112.675921931							Taylor et al. 2004	Reported Location Utm (349600,4023102)
1020	Taylor-04	SLIM-TCK-SP		Slimy TiCreek Spring			Grand Canyon - Central	Regional	Spring	Muav Ls			36.3255843881	-112.7540595973							Taylor et al. 2004	Reported Location Utm (342552,4021289)
1021	Wenrich-94	26A-W82		Rampart Springs			Grand Canyon - Central	Regional	Spring	Muav Ls			36.145009633	-113.109915787							Wenrich et al. 1994	
1022	Wenrich-94	51A-W82		National Canyon Spring			Grand Canyon - Central	Regional	Spring	Redwall Ls			36.213315326	-112.879363526							Wenrich et al. 1994	
1023	Wenrich-94	75A-W82		Warm Springs			Grand Canyon - Central	Regional	Spring	Muav Ls			36.196952793	-113.082413734							Wenrich et al. 1994	
1024	GCWC-02	GCNP-110		Mile 142 lower; B-35-03 27D			Grand Canyon - Central	Regional	Spring	Bright Angel Sh	Perennial	Contact	36.39778	-112.59897	03-Apr-01	03-Apr-01	0.01	0.01	0.01	1	Grand Canyon Wildlands Council 2002	Colorado River Mile 142, Right Site at 30 Meters from River
1025	GCWC-02-Map	M-298		Vaughn Springs; B-35-02 16			Grand Canyon - Central	Regional	Spring				36.42566	-112.50554							Grand Canyon Wildlands Council 2002	
1026	GCWC-02-Map	M-43		Hualapai Spring; B-35-02 19			Grand Canyon - Central	Regional	Spring				36.42208	-112.5467							Grand Canyon Wildlands Council 2002	
1027	NWIS-2	361403112314201		B-33-02 29 UNSURVEYED			Grand Canyon - East	Regional	Spring	Muav Ls			36.23414765	-112.5290733	20-Jan-02	20-Jan-02	0	0	0	1	USGS 2010b	
1028	NWIS-2	361143112270500	1	HP68 Royal Arch Creek at Mouth at Elves Chasm			Grand Canyon - East	Regional	Spring	Muav Ls			36.19525895	-112.4521255	05-May-76	19-Nov-81	103.231176	103.231176	103.231176	1	USGS 2010b	
1028	GCNP-1	ROYA006	2	Royal Arch Creek at Elves Chasm			Grand Canyon - East	Regional	Spring	Tapeats Ss/ Travertine			36.196547604	-112.450664539	21-Mar-05	19-Aug-08	80	417	158	5	Grand Canyon National Park 2010a	
1029	GCNP-1	COLO126		Traililobite? Spring (below lower Fossil camp)			Grand Canyon - East	Regional	Spring	Bright Angel Sh			36.278109921	-112.515566508	22-Oct-07	22-Oct-07	2.36	2.36	2.36	1	Grand Canyon National Park 2010a	
1030	Taylor-04	RM125-SP		River Mile 125 Spring	125		Grand Canyon - East	Regional	Spring	Muav Ls			36.2636594662	-112.5231207658							Taylor et al. 2004	Reported Location Utm (363175,4014068)
1031	GWSI-1	361153112121501	1	Crytsal Spring; A-32-02 05D			Grand Canyon - North Rim	Regional	Spring	Alluvium	Perennial	Seepage of Filtration	36.19803711	-112.204895042	21-Jul-69	21-Jul-69	90	90	90	1	ADWR 2009b	
1031	NWIS-2	361153112121501	2	A-32-02 05D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Holocene Alluvium			36.19803666	-112.2048947							USGS 2010b	
1032	GWSI-1	361043112105501	1	Dragon Spring; A-32-02 09D			Grand Canyon - North Rim	Regional	Spring	Alluvium	Perennial	Seepage of Filtration	36.178592533	-112.182671314	30-Jul-69	30-Jul-69	627	627	627	1	ADWR 2009b	
1032	NWIS-2	361043112105501	2	A-32-02 09D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Holocene Alluvium			36.17859264	-112.1826718							USGS 2010b	
1033	GWSI-1	360910112074801	1	Phantom Spring; A-32-02 24D			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture	36.152760225	-112.130725718	15-Aug-69	15-Aug-69	72	72	72	1	ADWR 2009b	
1033	NWIS-2	360910112074801	2	A-32-02 24D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.15276	-112.1307257							USGS 2010b	
1034	GWSI-1	361143112020701	1	Roaring Spring; A-32-03 01C			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave	36.195260893	-112.036001817							ADWR 2009b	
1034	NWIS-2	361143112020701	2	A-32-03 01C UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.19526067	-112.0360016	11-Nov-61	01-Feb-66	2540	2540	2540	1	USGS 2010b	
1035	GWSI-1	361125112034001	1	Transept Spring; A-32-03 10A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture	36.190260646	-112.061835395	17-Aug-69	17-Aug-69	54	54	54	1	ADWR 2009b	
1035	NWIS-2	361125112034001	2	A-32-03 10A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.1902604	-112.0618355							USGS 2010b	
1036	GWSI-1	361012112043501	1	Ribbon Spring; A-32-03 16D			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture	36.169982595	-112.077113527	16-Aug-69	16-Aug-69	184	184	184	1	ADWR 2009b	
1036	NWIS-2	361012112043501	2	A-32-03 16D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.16998259	-112.0771134							USGS 2010b	
1037	GWSI-1	360935112063601	1	Haunted Spring; A-32-03 19A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture	36.159704351	-112.110725273	15-Aug-69	15-Aug-69	430	430	430	1	ADWR 2009b	

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Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1037	NWIS-2	360935112063601	2	A-32-03 19A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.15970457	-112.1107253							USGS 2010b	
1038	GWSI-1	361723112153601	1	Abyss River Spring; A-33-01 02A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave	36.289702709	-112.26073029	13-Jul-69	13-Jul-69	403	403	403	1	ADWR 2009b	
1038	NWIS-2	361723112153601	2	A-33-01 02A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.2897029	-112.2607303							USGS 2010b	
1039	GWSI-1	361257112013501	1	Emmett Spring; A-33-03 36A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave	36.215815939	-112.027112882	22-Jul-69	22-Jul-69	215	215	215	1	ADWR 2009b	
1039	GCNP-1	BRIG005	2	Emmett Spring Source			Grand Canyon - North Rim	Regional	Spring				36.212946316	-112.023272169							Grand Canyon National Park 2010a	
1039	NWIS-2	361257112013501	3	A-33-03 36A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.21581627	-112.0271128							USGS 2010b	
1040	GWSI-1	361320112003701	1	Angel Spring; A-33-04 30D			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave	36.222205106	-112.011001583	24-Jul-69	24-Jul-69	5734.4	5734.4	5734.4	1	ADWR 2009b	
1040	NWIS-2	361320112003701	2	A-33-04 30D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.2222053	-112.0110014							USGS 2010b	
1040	GCNP-1	BRIG004	3	Angel Spring			Grand Canyon - North Rim	Regional	Spring	Muav LS			36.22171776	-112.011648406	13-Sep-07	02-Jun-08	5413	5413	5413	1	Grand Canyon National Park 2010a	
1041	GWSI-1	361808112180801	1	Shinumo Spring; A-34-01 33B			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture	36.302202991	-112.302953982	13-Jul-69	13-Jul-69	851	851	851	1	ADWR 2009b	
1041	NWIS-2	361808112180801	2	A-34-01 33B UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.3022032	-112.3029542							USGS 2010b	
1042	GWSI-1	361740112175501	1	Noble Spring; A-34-01 33C			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture	36.294424848	-112.299342782	13-Jul-69	13-Jul-69	54	54	54	1	ADWR 2009b	
1042	NWIS-2	361740112175501	2	A-34-01 33C UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls			36.29442529	-112.2993429							USGS 2010b	
1043	GCNP-1	ROAR004		Roaring Springs at GRCA inlet pipe			Grand Canyon - North Rim	Regional	Spring	Muav LS			36.1952778	-112.035							Grand Canyon National Park 2010a	
1044	GCWC-02-Map	M-110		A-32.5-03 35D			Grand Canyon - North Rim	Regional	Spring				36.19612	-112.0338							Grand Canyon Wildlands Council 2002	
1045	GCWC-02-Map	M-111		A-32.5-03 35D			Grand Canyon - North Rim	Regional	Spring				36.19532	-112.03293							Grand Canyon Wildlands Council 2002	
1046	GCWC-02-Map	M-214		Roaring Springs; A-32.5-03 35D			Grand Canyon - North Rim	Regional	Spring				36.19674	-112.03529							Grand Canyon Wildlands Council 2002	
1047	NWIS-2	361119112271501	1	Elves Chasm Spring; A-32-02 01 UNSURVEYED			Grand Canyon - South Rim	Regional	Spring	Redwall Ls			36.18859238	-112.4549033	23-Mar-02	23-Mar-02	8.976624	8.976624	8.976624	1	USGS 2010b	
1047	Taylor-04	ELV-CH	2	Elves Chasm			Grand Canyon - South Rim	Regional	Spring	Muav Ls			36.1889449179	-112.4542929997							Taylor et al. 2004	Reported Location Utm (369234,4005685)
1048	NPS_All_Hydro	HP-8c					Grand Canyon - South Rim	Regional	Spring				36.1946206411	-112.341560761							Grand Canyon National Park 2010b	
1049	NPS_All_Hydro	HP-65a					Grand Canyon - South Rim	Regional	Spring				36.1856175423	-112.458221556							Grand Canyon National Park 2010b	
1050	Wenrich-94	28A-W82	1	Diamond Creek Spring (Upper Diamond Spring); B-27-09 15CDC			Grand Canyon - West	Regional	Spring	Redwall Ls			35.719990029	-113.23159471							Wenrich et al. 1994	
1050	NWIS-2	354311113135200	2	Diamond Creek Spring; B-27-09 15CDC			Grand Canyon - West	Regional	Spring	Redwall Ls			35.71971226	-113.2318725	19-May-93	09-Jun-94	242.368848	278.275344	260.322096	2	USGS 2010b	
1051	NWIS-2	354248113153800	1	Diamond Spring; B-27-09 20ACB			Grand Canyon - West	Regional	Spring	Muav Ls			35.7133234	-113.261318	19-May-93	09-Dec-94	251.345472	255.833784	253.589628	2	USGS 2010b	
1051	Wenrich-94	58A-W82	2	Diamond Spring			Grand Canyon - West	Regional	Spring	Muav Ls			35.713323371	-113.261040235							Wenrich et al. 1994	
1052	NWIS-2	354302113174700		B-27-10 24ABB			Grand Canyon - West	Regional	Spring	Muav Ls			35.71721195	-113.2971527	19-May-93	09-Dec-94	8.976624	139.137672	82.28572	3	USGS 2010b	
1053	NWIS-2	354151113173601	1	Blue Mountain Seep; B-27-10 25ADC			Grand Canyon - West	Regional	Spring	Redwall Ls			35.69749009	-113.2940969							USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1053	Wenrich-94	62A-W82	2	Blue Mtn Seep			Grand Canyon - West	Regional	Spring	Bright Angel Sh			35.696934514	-113.292707945							Wenrich et al. 1994	
1054	NWIS-2	354406113263400		Travertine Canyon Spring; B-27-11 10 UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls			35.73498826	-113.4435468	15-May-93	08-Dec-94	538.59744	897.6624	748.052	3	USGS 2010b	
1055	NWIS-2	354250113343800	1	Hindu Spring; B-27-12 20ACA			Grand Canyon - West	Regional	Spring	Muav Ls			35.71387756	-113.577996	16-May-93	16-May-93	125.672736	125.672736	125.672736	1	USGS 2010b	
1055	NURE	23027	2				Grand Canyon - West	Regional	Spring				35.714088672	-113.578573815							USGS 2009b	
1056	NWIS-2	354550113313400		Bridge Canyon Spring; B-28-12 35 UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls			35.76387655	-113.526883	06-Aug-92	08-Dec-94	26.929872	215.438976	81.911694	4	USGS 2010b	
1057	NWIS-2	355750113183600		Granite Park Spring; B-30-10 25 UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls			35.96387456	-113.3107647	13-Oct-93	13-Oct-93	13.464936	13.464936	13.464936	1	USGS 2010b	
1058	NWIS-2	355750113183601		B-30-10 25UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls			35.96387456	-113.3107647							USGS 2010b	
1059	NWIS-2	354855113183300		Granite Spring Canyon; UNSURVEYEDEYED			Grand Canyon - West	Regional	Spring	Muav Ls			35.81526579	-113.309931	19-May-93	19-May-93	58.348056	58.348056	58.348056	1	USGS 2010b	
1060	Wenrich-94	78A+B-W82		Three Springs			Grand Canyon - West	Regional	Spring	Muav Ls			35.885542513	-113.293541844							Wenrich et al. 1994	
1061	Taylor-04	RM213-SP		River Mile 213 Spring	213		Grand Canyon - West	Regional	Spring	Bright Angel Sh			35.9185011765	-113.3358468389							Taylor et al. 2004	Reported Location Utm (289236,3977233)
1062	Wenrich-94	53A-W82		East Diamond Spring			Grand Canyon - West	Regional	Spring	Muav Ls			35.718878925	-113.254651124							Wenrich et al. 1994	
1063	Wenrich-94	5A-W82		Rocky Spring			Grand Canyon - West	Regional	Spring	Bright Angel Sh			35.749433026	-113.363821795							Wenrich et al. 1994	
1064	GCWC-02	GCNP-113		Spring Canyon; B-30-10 10B			Grand Canyon - West	Regional	Spring	Muav Ls	Perennial	Contact	36.01817	-113.35531	06-Apr-01	06-Apr-01	32.4	32.4	32.4	1	Grand Canyon Wildlands Council 2002	in Spring Canyon, Approximately 0.25 Miles from the Colorado River at River Mile 204
1065	GCWC-02-Map	M-199		Cedar Spring; B-32-10 23DA			Grand Canyon - West	Regional	Spring				36.15757	-113.32541							Grand Canyon Wildlands Council 2002	
1066	GCWC-02-Map	M-5		Cane Spring; B-32-09 22CD			Grand Canyon - West	Regional	Spring				36.15426	-113.2413							Grand Canyon Wildlands Council 2002	
1067	GCWC-02-Map	M-163		Shanley Spring; B-29-10 28DAA			Grand Canyon - West	Regional	Spring				35.8806	-113.35778							Grand Canyon Wildlands Council 2002	
1068	NWIS-2	361524112420400		Fern Spring; B-33-04 11 UNSURVEYED			Havasu Creek	Regional	Spring	Redwall Ls			36.25664897	-112.7018576	24-Aug-94	24-Aug-94	8	8	8	1	USGS 2010b	
1069	NWIS-2	361303112411200	1	Havasu Spring; B-33-04 26 UNSURVEYED			Havasu Creek	Regional	Spring	Redwall Ls			36.21748238	-112.6874123	23-Aug-94	23-Aug-94	28700	28700	28700	1	USGS 2010b	
1069	M&A-93b	HS	2	Havasu Spring			Havasu Creek	Regional	Spring	Redwall-Muav Aquifer			36.216944	-112.686111							M&A 1993b	Laboratory Tested By Tma
1070	GWSI-1	361716111574501	1	At Last Spring; A-33-04 03B			Kaibab Plateau	Regional	Spring	Muav Ls	Perennial	Tubular Cave	36.287761971	-111.96322275	29-Jul-69	29-Jul-69	260	260	260	1	ADWR 2009b	
1070	NWIS-2	361716111574501	2	A-33-04 03B UNSURVEYED			Kaibab Plateau	Regional	Spring	Muav Ls			36.28776175	-111.9632228							USGS 2010b	
1071	GWSI-1	360745111411001	1	03 079-10.39X08.30			Little Colorado River	Regional	Spring	Redwall Ls		Fracture	36.129154907	-111.686819359							ADWR 2009b	
1071	NWIS-2	360745111411001	2	03 079-10.39X08.30			Little Colorado River	Regional	Spring	Redwall Ls			36.12915458	-111.6868195							USGS 2010b	
1072	GWSI-1	360629111411201	1	03 079-10.42X09.78			Little Colorado River	Regional	Spring	Redwall Ls		Fracture	36.108044063	-111.687375042							ADWR 2009b	
1072	NWIS-2	360629111411201	2	03 079-10.42X09.78			Little Colorado River	Regional	Spring	Redwall Ls			36.1080436	-111.6873747							USGS 2010b	
1073	GWSI-1	360710111412901	1	03 079-10.69X08.97			Little Colorado River	Regional	Spring	Redwall Ls		Fracture	36.119431922	-111.692097442							ADWR 2009b	
1073	NWIS-2	360710111412901	2	03 079-10.69X08.97			Little Colorado River	Regional	Spring	Redwall Ls			36.11943237	-111.6920973	01-Jan-66	01-Jan-66	11250	11250	11250	1	USGS 2010b	
1074	GWSI-1	360707111413301	1	03 079-10.78X09.05			Little Colorado River	Regional	Spring	Redwall Ls		Fracture	36.118598915	-111.69320848							ADWR 2009b	
1074	NWIS-2	360707111413301	2	03 079-10.78X09.05			Little Colorado River	Regional	Spring	Redwall Ls			36.118599	-111.6932085	01-Jan-66	01-Jan-66	15750	15750	15750	1	USGS 2010b	
1075	GWSI-1	360703111413801	1	03 079-10.81X09.10; GC-9			Little Colorado River	Regional	Spring	Redwall Ls	Perennial	Fracture	36.117487905	-111.694597525							ADWR 2009b	
1075	NWIS-2	360703111413801	2	03 079-10.81X09.10			Little Colorado River	Regional	Spring	Redwall Ls			36.1174879	-111.6945974							USGS 2010b	
1076	GWSI-1	360700111413701	1	Blue Spring; 03 079-10.81X09.20			Little Colorado River	Regional	Spring	Redwall Ls	Perennial	Fracture	36.116654919	-111.694319499							ADWR 2009b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1076	M&A-93b	BS	2	Blue Spring			Little Colorado River	Regional	Spring	Redwall-Muav Aquifer			36.116944	-111.692778							M&A 1993b	
1076	NWIS-2	360700111413701	3	03 079-10.81X09.20			Little Colorado River	Regional	Spring	Redwall Ls			36.11665458	-111.6943196	14-Jun-50	16-Feb-02	43536.6264	48000	45768.3132	2	USGS 2010b	
1077	GWSI-1	361048111421801	1	03 079-11.49X04.86			Little Colorado River	Regional	Spring	Redwall Ls		Fracture	36.179987335	-111.705710045	15-Mar-67	15-Mar-67	100	100	100	1	ADWR 2009b	
1077	NWIS-2	361048111421801	2	03 079-11.49X04.86			Little Colorado River	Regional	Spring	Redwall Ls			36.17998734	-111.70571							USGS 2010b	
1078	GWSI-1	361119111422101	1	03 079-11.50X04.22			Little Colorado River	Regional	Spring	Redwall Ls			36.188598267	-111.706543223	15-Mar-67	15-Mar-67	50	50	50	1	ADWR 2009b	
1078	NWIS-2	361119111422101	2	03 079-11.50X04.22			Little Colorado River	Regional	Spring	Redwall Ls			36.18859838	-111.7065436							USGS 2010b	
1079	GWSI-1	361112111430001	1	GC-18 ; 03 079-12.12X04.38			Little Colorado River	Regional	Spring	Muav Ls	Perennial	Fracture	36.186654178	-111.717377685							ADWR 2009b	
1079	NWIS-2	361112111430001	2	03 079-12.12X04.38			Little Colorado River	Regional	Spring	Muav Ls			36.18665385	-111.7173774							USGS 2010b	
1080	GWSI-1	361113111434001	1	GC-19,20,21; 03 079-12.75X04.30			Little Colorado River	Regional	Spring	Muav Ls		Fracture	36.186931074	-111.728489196							ADWR 2009b	
1080	NWIS-2	361113111434001	2	03 079-12.75X04.30			Little Colorado River	Regional	Spring	Muav Ls			36.1869315	-111.728489							USGS 2010b	
1081	GWSI-1	361119111435201	1	03 079-12.93X04.23			Little Colorado River	Regional	Spring	Muav Ls			36.188598036	-111.731822375							ADWR 2009b	
1081	NWIS-2	361119111435201	2	03 079-12.93X04.23			Little Colorado River	Regional	Spring	Muav Ls			36.18859815	-111.7318225							USGS 2010b	
1082	GWSI-1	361129111440701	1	03 079-13.11X04.05			Little Colorado River	Regional	Spring	Muav Ls			36.191375979	-111.73598961							ADWR 2009b	
1082	NWIS-2	361129111440701	2	03 079-13.11X04.05			Little Colorado River	Regional	Spring	Muav Ls			36.19137587	-111.7359894							USGS 2010b	
1083	ONWI-85	Spr08		Little Colorado River; 4.5 miles up from mouth; North bank			Little Colorado River	Regional	Spring	Bright Angel Sh			36.1934945919	-111.739428957	19-Sep-82	19-Sep-82	6	6	6	1	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in the Redwall Limestone at River Level; Located on the North Bank of the Little Colorado River in Bright Angel Shale; Samples Considered Representative of in Situ C
1084	GWSI-1	361535111492001	1	03 062-04.05X16.52			Marble Canyon	Regional	Spring	Bright Angle Sh	Perennial	Fracture	36.259707611	-111.822938403	01-Sep-67	01-Sep-67	5	5	5	1	ADWR 2009b	
1084	NWIS-2	361535111492001	2	03 062-04.05X16.52			Marble Canyon	Regional	Spring	Bright Angel Sh			36.2597078	-111.8229386							USGS 2010b	
1085	Taylor-04	BERTS-CAN	1	Berts Canyon			Marble Canyon	Regional	Spring	Muav Ls			36.3980194196	-111.8858468002							Taylor et al. 2004	Reported Location Utm (420561,4028259)
1085	NWIS-2	362354111530701	2	A-35-05 32D UNSURVEYED			Marble Canyon	Regional	Spring				36.39831885	-111.8859989							USGS 2010b	
1085	GCNP-1	LOPE001	3	Loper Spring			Marble Canyon	Regional	Spring				36.3975	-111.8869443	14-Oct-07	14-Oct-07	0.36	0.36	0.36	1	Grand Canyon National Park 2010a	
1086	SIR-2010-5025	362434111533601	1	Buck Farm Spring; A-35-05 29			Marble Canyon	Regional	Spring				36.409444	-111.893333	23-Aug-09	23-Aug-09	0.59	0.59	0.59	1	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of the Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
1086	GCNP-1	BUCK002	2	Buck Farm			Marble Canyon	Regional	Spring				36.409685498	-111.893617953							Grand Canyon National Park 2010a	
1086	NWIS-1	362434111533601	3				Marble Canyon	Regional	Spring				36.40944444	-111.89333333							USGS 2009a	
1087	GCNP-1	COLO055		50-mile (Hackberry) Spring	50R		Marble Canyon	Regional	Spring	Bright Angel Sh			36.335	-111.8611111							Grand Canyon National Park 2010a	
1088	GCNP-1	NANK003		Nankoweap 1-mile Spring			Marble Canyon	Regional	Spring	Muav LS			36.2972222	-111.8763888	15-Oct-07	15-Oct-07	174	174	174	1	Grand Canyon National Park 2010a	
1089	Taylor-04	SADDLE-CAN		Saddle Canyon			Marble Canyon	Regional	Spring	Muav Ls			36.3597455581	-111.9044271517							Taylor et al. 2004	Reported Location Utm (418855,4024029)
1090	GCWC-02	GCNP-103		Buck Farm; A-35-05 29B			Marble Canyon	Regional	Spring	Temple Butte Ls - Muav Ls	Perennial	Contact	36.40572	-111.87918							Grand Canyon Wildlands Council 2002	in Buck Farm Canyon 4Th of 7 Seeps, Approximately 0.5 Miles from the Colorado River at River Mile 40.9
1091	GCWC-02	GCNP-106		Nankoweap I mile; A-34-05 33C			Marble Canyon	Regional	Spring	Muav Ls	Perennial	Contact	36.29313	-111.87947	27-Mar-01	27-Mar-01	1.68	1.68	1.68	1	Grand Canyon Wildlands Council 2002	South Side of Nankoweap Canyon, Approximately 1 Mile from the Colorado River at River Mile 52

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1092	GCWC-02	GCNP-104		Saddle Canyon; A-34-05 07A			Marble Canyon	Regional	Spring	Muav Ls	Perennial	Fracture	36.37831	-111.89056							Grand Canyon Wildlands Council 2002	in Saddle Canyon, Approximately 0.75 Miles from the Colorado River at River Mile 47.1
1093	GWSI-1	353444113254901	1	Peach Springs No. 1; B-25-11 02CBC			Peach Springs, AZ	Regional	Spring				35.578880265	-113.431046911	15-Jun-84	15-Jun-84	70	70	70	1	ADWR 2009b	
1093	NWIS-2	353444113254901	2	B-25-11 02CBC			Peach Springs, AZ	Regional	Spring				35.57888015	-113.4310467							USGS 2010b	
1093	Wenrich-94	2A-W82	3	Peach Springs			Peach Springs, AZ	Regional	Spring	Muav Ls			35.578324572	-113.431046712							Wenrich et al. 1994	
1094	GWSI-1	353444113255101	1	Peach Springs No. 2; B-25-11 03DAD			Peach Springs, AZ	Regional	Spring				35.578880258	-113.431601934							ADWR 2009b	
1094	NWIS-2	353445113255000	2	Peach Spring; B-25-11 03DAA			Peach Springs, AZ	Regional	Spring	Sedimentary Rocks			35.5791579	-113.4313245	10-Aug-92	31-Mar-95	28.2763656	85.277928	63.10566672	5	USGS 2010b	
1095	GWSI-1	353109113240201	1	Surprise Springs; B-25-11 25DBD			Peach Springs, AZ	Regional	Spring		Perennial	Tubular Cave	35.51915956	-113.401323749							ADWR 2009b	
1095	NWIS-2	353109113240201	2	B-25-11 25DBD			Peach Springs, AZ	Regional	Spring	Redwall Ls			35.51888145	-113.4018789	24-Sep-80	29-Mar-95	0.05	0.05	0.05	1	USGS 2010b	
1095	Wenrich-94	31A+B-W82	3	Surprise Springs			Peach Springs, AZ	Regional	Spring	Redwall Ls			35.518603663	-113.401878873							Wenrich et al. 1994	
1095	NURE	23017	4				Peach Springs, AZ	Regional	Spring				35.518492561	-113.402567803							USGS 2009b	
1096	Wenrich-94	72A-W82	1	Metuck Springs; B-26-10 07DCD			Peach Springs, AZ	Regional	Spring	Muav Ls			35.646657044	-113.383266919							Wenrich et al. 1994	
1096	NWIS-2	353848113225700	2	B-26-10 07DCD			Peach Springs, AZ	Regional	Spring	Sedimentary Rocks			35.646657	-113.3832669	18-May-93	08-Jun-94	0	4.488312	2.244156	2	USGS 2010b	
1097	NWIS-2	353643113241000	1	Mulberry Spring; B-26-11 25ACB			Peach Springs, AZ	Regional	Spring	Muav Ls			35.61193528	-113.4035455	06-Jun-94	06-Jun-94	4.488312	4.488312	4.488312	1	USGS 2010b	
1097	Wenrich-94	7A-W82	2	Mulberry Spring			Peach Springs, AZ	Regional	Spring	Muav Ls			35.611657544	-113.403267733							Wenrich et al. 1994	
1098	GWSI-1	353333113251801	1	Red Spring; B-25-11 14BAA			Peach Springs, AZ	Regional	Spring				35.559158683	-113.422435591	15-Jun-84	15-Jun-84	0.33	0.33	0.33	1	ADWR 2009b	
1098	Wenrich-94	1A-W82	2	Red Spring			Peach Springs, AZ	Regional	Spring	Muav Ls			35.558602791	-113.422990816							Wenrich et al. 1994	
1098	NURE	23019	3				Peach Springs, AZ	Regional	Spring				35.558691693	-113.422468594							USGS 2009b	
1099	GWSI-1	353532113262101	1	Lower Peach Springs; B-26-11 34DBC			Peach Springs, AZ	Regional	Spring				35.592212949	-113.439936246							ADWR 2009b	
1099	Wenrich-94	3A-W82	2	Lower Peach Springs			Peach Springs, AZ	Regional	Spring	Muav Ls			35.591935357	-113.440213658							Wenrich et al. 1994	
1099	NURE	23029	3				Peach Springs, AZ	Regional	Spring				35.592590945	-113.44006925							USGS 2009b	
1100	GWSI-1	354014113251601		Mesquite Spring; B-26-11 02ACB			Peach Springs, AZ	Regional	Spring				35.670545622	-113.421879376							ADWR 2009b	
1101	Wenrich-94	6A-W82		Mesquite Spring; Bright Angel Shale in landslide block adjacent to Hurricane Fault			Peach Springs, AZ	Regional	Spring	Bright Angel Sh			35.670267429	-113.421879476							Wenrich et al. 1994	
1102	GCNP-1	BRIG003		Emmett Spring at Old Bright Angel Trail			Grand Canyon - North Rim	Regional	Spring stream				36.210593969	-112.024253868	13-Sep-07	02-Jun-08	197.7	441	290.2	3	Grand Canyon National Park 2010a	
1103	NWIS-2	355308113182600	1	Three Springs Canyon above the Mouth Spring; B-29-10 25 UNSURVEYED			Grand Canyon - West	Regional	Spring stream	Muav Ls			35.88554246	-113.3079867	11-May-90	08-Jan-95	8.976624	237.880536	126.5703984	5	USGS 2010b	
1103	Taylor-04	THREE-SP	2	Three Springs			Grand Canyon - West	Regional	Spring stream	Muav Ls			35.8884504782	-113.308324088							Taylor et al. 2004	Reported Location Utm (291641,3973840)
1103	GCNP-1	THRE001	3	Three Springs			Grand Canyon - West	Regional	Spring stream	Tapeats Ss			35.885658024	-113.308119683	26-Oct-07	26-Oct-07	66.3	66.3	66.3	1	Grand Canyon National Park 2010a	
1103	NURE	43536	4				Grand Canyon - West	Regional	Spring stream				35.88538691	-113.308864507							USGS 2009b	
1104	Wenrich-94	79A-W82		Hindu Canyon			Grand Canyon - West	Regional	Spring stream	Muav Ls			35.703044438	-113.57966274							Wenrich et al. 1994	
1122	NWIS-2	360932111512001	1	Moonshine Spring; A-32-05 16A UNSURVEYED			Grand Canyon - East	Below regional	Spring				36.15887434	-111.8562718							USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1122	GCNP-1	LAVA004	2	Moonshine Spring			Grand Canyon - East	Below regional	Spring				36.159233336	-111.853750005	18-Mar-05	26-Mar-06	20.3	20.3	20.3	1	Grand Canyon National Park 2010a	
1123	GCNP-1	COLO117		117-mile Spring	117L		Grand Canyon - East	Below regional	Spring	Tapeats Ss			36.201707132	-112.457088556							Grand Canyon National Park 2010a	
1124	GCNP-1	UNKA002		Unkar (Ambush) Spring			Grand Canyon - East	Below regional	Spring	Dox Ss			36.094390035	-111.89559985							Grand Canyon National Park 2010a	
1125	GCWC-02	GCNP-107		Dead Duck; A-31-05 03C			Grand Canyon - East	Below regional	Spring	Dox Fm	Perennial	Contact; Fracture	36.09503	-111.84681	28-Mar-01	28-Mar-01	0.01	0.01	0.01	1	Grand Canyon Wildlands Council 2002	Colorado River Mile 70, Right Site at 20 Meters from River
1126	NWIS-2	354815113192000		222 Mile Canyon Springs	222		Grand Canyon - West	Below regional	Spring	Granite			35.80415479	-113.322987	25-Oct-92	15-Oct-93	2.244156	4.488312	3.74026	3	USGS 2010b	
1127	NWIS-2	354522113264800	1	Travertine Falls Spring; B-27-11 03 UNSURVEYED			Grand Canyon - West	Below regional	Spring	Tapeats Ss			35.756099	-113.4474358	23-Aug-91	05-Jun-94	53.859744	76.301304	65.828576	3	USGS 2010b	
1127	Wenrich-94	18A-W82	2	Travertine Falls Spring			Grand Canyon - West	Below regional	Spring	Granite			35.755821198	-113.44771353							Wenrich et al. 1994	
1128	NWIS-2	355502113195901		B-29-10 14 1 UNSURVEYED			Grand Canyon - West	Below regional	Spring	Tapeats Ss			35.91720866	-113.3338208							USGS 2010b	
1129	NWIS-2	355502113195900		Pumpkin Spring at River Mile 213; B-29-10 14 2 UNSURVEYED	213		Grand Canyon - West	Below regional	Spring	Tapeats Ss			35.91720866	-113.3338208	13-Oct-93	08-Jan-95	2.244156	4.488312	3.366234	2	USGS 2010b	
1130	Wenrich-94	67A-W82		Robbers Roost Spring			Grand Canyon - West	Below regional	Spring	Vishnu Schist			35.718045316	-113.296319334							Wenrich et al. 1994	
1131	NWIS-2	355459113195900	1	River Mile 212.9, GCNP: Pumpkin Spring	212.9		Grand Canyon - West	Below regional	Spring				35.91637534	-113.3338208							USGS 2010b	
1131	GCNP-1	COLO002	2	Pumpkin Spring			Grand Canyon - West	Below regional	Spring	Tapeats Ss/ Travertine			35.916133335	-113.334216662							Grand Canyon National Park 2010a	
1131	Peterson-77	CF-16	3	Pumpkin Spring; River Mile 212.9	212.9		Grand Canyon - West	Below regional	Spring	Tapeats Ss			35.916375354	-113.333820892							Peterson et al. 1977	
1131	Wenrich-94	77A-W82	4	Pumpkin Spring			Grand Canyon - West	Below regional	Spring	Tapeats Ss			35.916653149	-113.33270966							Wenrich et al. 1994	
1131	Taylor-04	PUMPKIN-SP	5	Pumpkin Spring			Grand Canyon - West	Below regional	Spring	Tapeats Ss			35.8851120931	-113.3070863045							Taylor et al. 2004	Reported Location Utm (291744,3973467)
1132	NWIS-2	354503113252600	1	Travertine Canyon above mouth at River Mile 228	228		Grand Canyon - West	Below regional	Spring				35.75082145	-113.4246572	22-Aug-91	08-Dec-94	255.833784	1077.19488	628.36368	5	USGS 2010b	
1132	Wenrich-94	17A-W82	2	Travertine Falls			Grand Canyon - West	Below regional	Spring	Vishnu Schist			35.750543715	-113.425768374							Wenrich et al. 1994	
1133	GCNP-1	COLO206		205.8-mile (Orchid) Spring	205.8R		Grand Canyon - West	Below regional	Spring				36.000259783	-113.340607632							Grand Canyon National Park 2010a	
1134	NURE	23028					Grand Canyon - West	Below regional	Spring				35.761788477	-113.362266139							USGS 2009b	
1135	Wenrich-94	21A-W82		Seep south of Separation Canyon			Grand Canyon - West	Below regional	Spring	Granite			35.807765549	-113.566884352							Wenrich et al. 1994	
1136	Wenrich-94	22A-W82		Seep south of Separation Canyon			Grand Canyon - West	Below regional	Spring	Granite			35.807765556	-113.567717684							Wenrich et al. 1994	
1137	Taylor-04	NANK-TWIN-SP		Nankoweap Twin Spring			Marble Canyon	Below regional	Spring	Quartzite/schist			36.2817077983	-111.8889287016							Taylor et al. 2004	Reported Location Utm (420166,4015360)
1138	GCWC-02	GCNP-105		Butte Fault upper; A-33-05 05C			Marble Canyon	Below regional	Spring		Perennial	Fracture; Fault	36.28231	-111.89014	27-Mar-01	27-Mar-01	80	80	80	1	Grand Canyon Wildlands Council 2002	in Nankoweap Canyon, Approximately 2.5 Miles from the Colorado River at River Mile 52, 30 Meters from Gcnp105A
1139	GCWC-02	GCNP-105a		Butte Fault lower; A-33-05 05C			Marble Canyon	Below regional	Spring		Perennial	Fracture; Fault	36.28231	-111.89014	27-Mar-01	27-Mar-01	10	10	10	1	Grand Canyon Wildlands Council 2002	in Nankoweap Canyon, Approximately 2.5 Miles from the Colorado River at River Mile 52, 30 Meters from Gcnp105

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1140	GCNP-1	ROAR002		Roaring Springs below pumphouse			Grand Canyon - North Rim	Below regional	Spring stream	Tapeats Ss			36.192647745	-112.032294806	17-Jul-07	15-Oct-08	1826.8	5267	2794	7	Grand Canyon National Park 2010a	
1141	GCNP-1	ROAR003		Roaring Springs above main springs			Grand Canyon - North Rim	Below regional	Spring stream	Bright Angel Sh			36.194852381	-112.036939481	17-Jul-07	01-Jun-08	72	220.12	113.7962857143	7	Grand Canyon National Park 2010a	
1142	Wenrich-94	19A-W82		Lost Travertine Falls Spring			Grand Canyon - West	Below regional	Spring stream	Tapeats Ss			35.756098609	-113.498270898							Wenrich et al. 1994	
1143	Wenrich-94	20A-W82		1/4 mile below Bridge Canyon Spring			Grand Canyon - West	Below regional	Spring stream	Vishnu Schist/ granite			35.769154336	-113.527160796							Wenrich et al. 1994	
1144	NWIS-2	09401200		Little Colorado River at Cameron, AZ			Cameron, AZ	N/A	Stream	N/A	Intermittent		35.8777729	-111.4118096							USGS 2010b	
1145	NWIS-2	09403850	1	Kanab Creek above mouth near Supai, AZ			Grand Canyon - Central	N/A	Stream				36.39581624	-112.6318566	08-May-90	16-Apr-93	1539.491016	2199272.88	75379.8863877073	41	USGS 2010b	
1145	GCNP-1	KANA002	2	Kanab Creek Below old USGS Site			Grand Canyon - Central	N/A	Stream				36.3947222	-112.6325	04-Apr-06	23-Oct-07	1842	3662	2752	2	Grand Canyon National Park 2010a	
1146	NWIS-2	361518112523900	1	National Canyon above mouth at River Mile 166.5 in Hualapai	166.5		Grand Canyon - Central	N/A	Stream	N/A			36.2549818	-112.8782527							USGS 2010b	
1146	NWIS-1	361518112523900	2	National Canyon above mouth at River Mile 166.5 in Hualapai	166.5		Grand Canyon - Central	N/A	Stream	N/A			36.2549818	-112.87825272							USGS 2009a	
1147	GCNP-1	140M001		140 Mile Canyon	140L		Grand Canyon - Central	N/A	Stream				36.3983333	-112.5683333	04-Apr-06	04-Apr-06	0.203	0.203	0.203	1	Grand Canyon National Park 2010a	
1148	GCNP-1	DEER001		Deer Creek Below Main Falls			Grand Canyon - Central	N/A	Stream				36.3886111	-112.5083333	15-Jul-06	15-Jul-06	2612	2612	2612	1	Grand Canyon National Park 2010a	
1149	GCNP-1	DEER002		Deer Creek Patio			Grand Canyon - Central	N/A	Stream	Bright Angel Sh			36.392244048	-112.506172694	23-Oct-07	20-Aug-08	2553	2862	2707.5	2	Grand Canyon National Park 2010a	
1150	GCNP-1	DEER006		Deer Creek below middle confluence			Grand Canyon - Central	N/A	Stream				36.3975	-112.5052778	02-Apr-06	02-Apr-06	2115	2115	2115	1	Grand Canyon National Park 2010a	
1151	GCNP-1	MATK001		Matkatamiba near River	148.5L		Grand Canyon - Central	N/A	Stream				36.3422222	-112.6719444	04-Apr-06	16-Jul-06	59	59	59	1	Grand Canyon National Park 2010a	
1152	GCNP-1	OLO001		Olo Canyon at Waterfall	146R		Grand Canyon - Central	N/A	Stream				36.3705555	-112.6497222							Grand Canyon National Park 2010a	
1153	GCNP-1	STON003		Stone Creek near River bw. Falls			Grand Canyon - Central	N/A	Stream				36.347494717	-112.452453529	22-Mar-05	22-Oct-07	235	1021	571.3333333333	3	Grand Canyon National Park 2010a	
1154	GCNP-1	TAPE001		Tapeats Creek near River			Grand Canyon - Central	N/A	Stream	Alluvium			36.371255723	-112.468749603	15-Jul-06	19-Aug-08	19636	19636	19636	1	Grand Canyon National Park 2010a	
1155	GCNP-1	TAPE002		Tapeats above Thunder			Grand Canyon - Central	N/A	Stream				36.3933333	-112.4511111	01-Apr-06	01-Apr-06	21521	21521	21521	1	Grand Canyon National Park 2010a	
1156	GCNP-1	TAPE003		Tapeats below Thunder			Grand Canyon - Central	N/A	Stream				36.3905556	-112.4525	01-Apr-06	01-Apr-06	29683	29683	29683	1	Grand Canyon National Park 2010a	
1157	Taylor-96	HAVA-MO		Havasu Creek near mouth			Grand Canyon - Central	N/A	Stream				36.3140881049	-112.760158682							Taylor et al. 1996	Reported Location River Kilometer 252.3
1158	NWIS-2	09403000		Bright Angel Creek near Grand Canyon, AZ			Grand Canyon - East	N/A	Stream				36.10303836	-112.0962798	31-Dec-61	27-Aug-09	6148.98744	186264.948	29542.4715223881	67	USGS 2010b	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1159	STORET-1	GRCA_FIT_ BRIG02	1	Bright Angel Creek at mouth			Grand Canyon - East	N/A	Stream				36.0997222	-112.0938889							USEPA 2010	Bright Angel Creek is Located on the North Rim Within the Boundary of Grand Canyon National Park in the Bright Angel Creek Drainage, Downstream of Phantom Ranch.
1159	Fitz-96	BRIG	2	Bright Angel Creek (North Rim)			Grand Canyon - East	N/A	Stream		Perennial		36.0997222	-112.0938889							Fitzgerald 1996	
1159	Taylor-96	BRIG-MO	3	Bright Angel Creek near mouth			Grand Canyon - East	N/A	Stream				36.1013710665	-112.087131007							Taylor et al. 1996	Reported Location River Kilometer 141.5
1160	GCNP-1	CLEA001		Clear Creek near River			Grand Canyon - East	N/A	Stream				36.082359249	-112.035948853	27-Mar-06	17-Oct-07	828	970	899	2	Grand Canyon National Park 2010a	
1161	GCNP-1	CRYS001		Crystal near River			Grand Canyon - East	N/A	Stream	Alluvium			36.135516398	-112.244018568	21-Mar-05	18-Aug-08	200	2934.00171	1042.400342	5	Grand Canyon National Park 2010a	
1162	GCNP-1	SHIN001		Shinimo Creek near River			Grand Canyon - East	N/A	Stream				36.2372222	-112.3488889	14-Jul-06	14-Jul-06	3265	3265	3265	1	Grand Canyon National Park 2010a	
1163	GCNP-1	SHIN002		Shinimo Creek at Trail Xing			Grand Canyon - East	N/A	Stream	Hakatai Sh/ alluvium			36.241096307	-112.349969132	30-Mar-06	19-Aug-08	3490	5300	4395	2	Grand Canyon National Park 2010a	
1164	GCNP-1	SHIN003		Shinimo Creek Above Burro Canyon			Grand Canyon - East	N/A	Stream	Hakatai Sh/ alluvium			36.244306449	-112.348293806	11-Jul-07	12-Jul-07	4077	4361	4219	2	Grand Canyon National Park 2010a	
1165	GCNP-1	SHIN004		Shinumo Creek At WQ reference site			Grand Canyon - East	N/A	Stream	PC meta/ig			36.238868785	-112.349246447	13-Mar-09	13-Mar-09	6387	6387	6387	1	Grand Canyon National Park 2010a	
1166	GCNP-1	BRIG006		Bright Angel Creek above Roaring confluence			Grand Canyon - North Rim	N/A	Stream	Tapeats Ss			36.1933333	-112.0319444	04-Oct-07	02-Jun-08	3863.6	7855	5087.575	4	Grand Canyon National Park 2010a	
1167	GCNP-1	BRIG007		Phantom Creek at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream	PC meta/ign.			36.1163888	-112.0875	18-Mar-08	18-Mar-08	872.6	872.6	872.6	1	Grand Canyon National Park 2010a	
1168	GCNP-1	BRIG008		The Trancept at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream				36.1716666	-112.0402777	17-Mar-08	17-Mar-08	448.83	448.83	448.83	1	Grand Canyon National Park 2010a	
1169	GCNP-1	PHAN002		Haunted Creek at Phantom Creek confluence			Grand Canyon - North Rim	N/A	Stream	Channel alluvium			36.144764668	-112.120888122	27-May-08	27-May-08	660.43	660.43	660.43	1	Grand Canyon National Park 2010a	
1170	GCNP-1	PHAN003		Phantom Creek at Haunted Creek Confluence			Grand Canyon - North Rim	N/A	Stream	Channel alluvium			36.144887015	-112.121301121	27-May-08	27-May-08	60	60	60	1	Grand Canyon National Park 2010a	
1171	GCNP-1	RIBB001		Ribbon Falls below lower falls			Grand Canyon - North Rim	N/A	Stream	Shinumo Qtzite			36.1591667	-112.0552778	18-Mar-08	18-Mar-08	387.6	387.6	387.6	1	Grand Canyon National Park 2010a	
1172	GCNP-1	WALL001		Wall Creek at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream	Shinumo Qtzite			36.163523415	-112.046388172	17-Mar-08	28-Apr-08	763	3647	2205	2	Grand Canyon National Park 2010a	
1173	NWIS-2	09404200		Colorado River above Diamond Creek near Peach Spring			Grand Canyon - West	N/A	Stream	N/A	Perennial		35.7735994	-113.363544							USGS 2010b	
1174	GCNP-1	SPRI001		Spring Canyon			Grand Canyon - West	N/A	Stream				36.0186111	-113.3519444	07-Apr-06	26-Oct-07	223	2350	943	3	Grand Canyon National Park 2010a	
1175	GCNP-1	SPRI002		Spring Canyon			Grand Canyon - West	N/A	Stream				36.018337153	-113.353235966	26-Mar-05	20-Sep-05	295	692.74	493.87	2	Grand Canyon National Park 2010a	
1176	NURE	43538					Grand Canyon - West	N/A	Stream				35.7455882	-113.425968391							USGS 2009b	
1177	NURE	43540					Grand Canyon - West	N/A	Stream				35.772487594	-113.524071767							USGS 2009b	
1178	Wenrich-94	23A-W82		Mouth of Spencer Canyon; Spencer Canyon gravels			Grand Canyon - West	N/A	Stream	Alluvium?			35.823320973	-113.567717638							Wenrich et al. 1994	

Table E-1. Summary of Location and Discharge for Springs, Seeps, and Streams (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Number of Flow Rate Measurements	Reference	Comments
1179	NWIS-1	361308112413001		Sample point #25 Havasu Creek near Supai, AZ			Havasu Creek	N/A	Stream				36.21887129	-112.69241252							USGS 2009a	
1180	NURE	GCBH032R					Kaibab Plateau	N/A	Stream	KBBL Carbonate			36.510385145	-112.136130069							USGS 2009b	
1181	EFN-88b	SW-KC7	1	Kanab Creek at confluence with Colorado River			Kanab Creek - Lower	N/A	Stream				36.39214	-112.62961							Energy Fuels Nuclear 1988b	
1181	GCNP-1	KANA001	2	Kanab Creek at confluence with Colorado River			Kanab Creek - Lower	N/A	Stream				36.3922222	-112.6294443	16-Jul-06	16-Jul-06	1963	1963	1963	1	Grand Canyon National Park 2010a	
1181	Taylor-96	KANA-MO	3	Kanab Creek near mouth			Kanab Creek - Lower	N/A	Stream				36.3917926917	-112.618411291							Taylor et al. 1996	Reported Location River Kilometer 230.7
1182	NWIS-2	09402300		Little Colorado River above mouth near Desert View, AZ			Little Colorado River	N/A	Stream				36.1952642	-111.7771024	20-Jan-90	21-Feb-10	84380.2656	1032311.76	141640.841005	48	USGS 2010b	
1183	NWIS-2	361133111474500	1	River Mile 0.1, Little Colorado River			Little Colorado River	N/A	Stream				36.19248619	-111.7965476							USGS 2010b	
1183	Taylor-96	LCOL-MO	2	Little Colorado River near mouth			Little Colorado River	N/A	Stream				36.2010188935	-111.80024413							Taylor et al. 1996	Reported Location River Kilometer 98.5
1184	NWIS-2	361203111452501		River Mile 3.1, Little Colorado River			Little Colorado River	N/A	Stream				36.20082	-111.7576572	17-May-66	18-Nov-02	96947.5392	101884.6824	99416.1108	2	USGS 2010b	
1185	NWIS-2	361817111513200	1	Nankoweap Creek 100 meters from mouth of Colorado River, AZ			Marble Canyon	N/A	Stream				36.30470756	-111.8596075							USGS 2010b	
1185	GCNP-1	NANK001	2	Nankoweap Creek near River			Marble Canyon	N/A	Stream	Alluvium			36.3047222	-111.8616667	25-Mar-06	15-Oct-07	31	599	315	2	Grand Canyon National Park 2010a	
1186	GCNP-1	SADD002		Saddle Canyon	47.5R		Marble Canyon	N/A	Stream				36.3597222	-111.905	14-Oct-07	14-Oct-07	9.1	9.1	9.1	1	Grand Canyon National Park 2010a	

Notes:

[1] Record source is the database form used in the EIS compilation for the reference shown at the left. The record source identifier is the unique database code that identifies the record within each data source.

[2] Record rank is the order assigned to records from different data sources for the same site feature. The order is typically based on quality of the data and is used for display and analysis in the EIS.

Abbreviations:

Cen = Central
E = East
GCNP = Grand Canyon National Park
gpm = gallons per minute
ID = Identifier
L = Lower
Mts = Mountains
N = North
N/A = Not applicable
N/D = Not determined
NF = National Forest
Q = Flow Rate
RM = River Mile
W = West
WQ = Water Quality

Record Source/Reference:

ADWR = Arizona Department of Water Resources
BLM = Bureau of Land Management
D&M = Dames & Moore
EFN = Energy Fuels Nuclear, Inc.
Fitz = Fitzgerald
GCWC = Grand Canyon Wildlands Council
GRCA = Grand Canyon National Park
GWSI = Groundwater Site Inventory (maintained by ADWR)
M&A = Montgomery & Associates
NHD = National Hydrologic Data
NPS = National Park Service
NURE = National Uranium Resource Evaluation
NWIS = National Water Information System
ONWI = Office of Nuclear Waste Isolation
SIR = Scientific Investigations Report
STORET = U.S. EPA Storage and Retrieval sample database
USEPA = U.S. Environmental Protection Agency
USFS = U.S. Forest Service
USGS = U.S. Geological Survey

Site Geology:

BA = Bright Angel
CCNN = Coconino
CHNL = Chinle
Fm = Formation
ig = igneous
KBBL = Kaibab limestone
Ls = Limestone
Mbr = Member
meta = metamorphic
MNKP = Moenkopi
PC = Precambrian
PRMN = Permian
QTRN = Quaternary
Qtzite = Quartzite
Sh = Shale
Ss = Sandstone
TRSS = Triassic
UNKN = Unknown
U = Upper

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Appendix F

SITE INFORMATION FOR WATER QUALITY SAMPLES

Table F-1. Site Information for Water Quality Samples

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1	BLM-Legacy	LEG-199		Trap Spring; B-41-01 07AA		North	Kanab Plateau - North	Mesozoic	Spring					36.97426	-112.4348	Yes	BLM 2010d	Flow Actually 0.03 Gallons per Minute/Highway Allotment #5309
2	GCWC-02-Map	M-452		B-40-03 32		North	Kanab Plateau - North	Mesozoic	Spring					36.82497	-112.63856	No	Grand Canyon Wildlands Council 2002	No Spring on Topo
3	BLM_Field_Inv	BULR		Bulrush Seeps; B-39-04 14B		North	Kanab Plateau - North	Mesozoic	Spring		Perennial			36.7843187055	-112.69486883	Yes	BLM 2010d	
4	GWSI-1	363853113004001	1	Cunningham Spring; B-38-07 35DBD		North	Uinkaret Plateau - Central	Mesozoic	Spring	Moenkopi Fm		Seepage of Filtration		36.648040117	-113.011877158	No	ADWR 2009b	
4	NWIS-2	363853113004001	2	B-38-07 35DBD		North	Uinkaret Plateau - Central	Mesozoic	Spring	Moenkopi Fm				36.64803967	-113.0118773	No	USGS 2010b	
5	GWSI-1	364352112563301	1	Yellowstone Spring; B-39-06 33DCC		North	Yellowstone Mesa	Mesozoic	Spring	Shinarump Mbr		Contact		36.731096453	-112.94326452	Yes	ADWR 2009b	
5	NWIS-2	364352112563301	2	B-39-06 33DCC		North	Yellowstone Mesa	Mesozoic	Spring	Shinarump Mbr				36.73109657	-112.9432645	No	USGS 2010b	
5	BLM-Legacy	LEG-165	3	Yellowstone Spring; B-39-06 33DC		North	Yellowstone Mesa	Mesozoic	Spring					36.73102	-112.94299	Yes	BLM 2010d	Source on Private Land/First Trough on State--Last Trough on Public/Yellowstone Allotment #5215,Esplin
6	GCWC-02-Map	M-400	1	Yellowstone Spring (source); B-38-06 04AB		North	Yellowstone Mesa	Mesozoic	Spring					36.72789	-112.94245	No	Grand Canyon Wildlands Council 2002	
6	NURE	GCBE501R	2			North	Yellowstone Mesa	Mesozoic	Spring	PRMN Ss				36.727785414	-112.942764435	Yes	USGS 2009b	
7	NURE	GCAE511R				North	Yellowstone Mesa	Mesozoic	Spring	TRSS Carbonate				36.781685749	-112.846560931	Yes	USGS 2009b	
8	BLM-Legacy	LEG-142		Moonshine Spring; B-39-05 17ADD		North	Yellowstone Mesa	Mesozoic	Spring					36.78172	-112.84672	Yes	BLM 2010d	Spring Flow .283 Gallons per Minute/75' Tunnel,Steel Water Trough 300 Gal 20' of 3/4 Pipe Year 5-19-60/Report 1985:Bezanson, Schoppman (Old Trough and Pipeline Coming Down Fro
9	NWIS-2	363902112522001		B-38-05 31		North	Antelope Valley	Mesozoic	Well	Moenkopi Fm			4663	36.65054028	-112.872982	No	USGS 2010b	
10	NWIS-2	364812112451501		B-39-04 05CCC		North	Antelope Valley	Mesozoic	Well	Moenkopi Fm			60	36.80331916	-112.754924	No	USGS 2010b	
11	NWIS-2	364422112461201		Bulrush Well; B-39-04 31BCD		North	Antelope Valley	Mesozoic	Well				130	36.73943048	-112.7707564	No	USGS 2010b	BLM reported pump shaft broken; DTW reported to be 18 feet 7/9/85
12	NWIS-2	364858112485101		B-39-05 03ABA		North	Antelope Valley	Mesozoic	Well	Shinarump Mbr			45	36.8160967	-112.814927	Yes	USGS 2010b	
13	NWIS-2	364851112493601		B-39-05 03BBC		North	Antelope Valley	Mesozoic	Well	Shinarump Mbr			45	36.81415226	-112.8274275	No	USGS 2010b	
14	NWIS-2	364850112492801		B-39-05 03BBD		North	Antelope Valley	Mesozoic	Well	Shinarump Mbr			45	36.81387449	-112.8252052	No	USGS 2010b	
15	NWIS-2	364854112495001	1	B-39-05 04AAC		North	Antelope Valley	Mesozoic	Well	Shinarump Mbr				36.81498558	-112.8313166	No	USGS 2010b	
15	NURE	GCAE512R	2			North	Antelope Valley	Mesozoic	Well	TRSS Clastics - Coarse				36.816585573	-112.828760968	Yes	USGS 2009b	
16	NWIS-2	364809112482801	1	B-39-05 11BBB		North	Antelope Valley	Mesozoic	Well				150	36.8024857	-112.8085375	No	USGS 2010b	
16	NURE	GCAE513R	2			North	Antelope Valley	Mesozoic	Well	TRSS Clastics - Coarse				36.802785706	-112.808859726	Yes	USGS 2009b	
17	NWIS-2	364503112482301		Cedar Knoll Windmill; B-39-05 26CBB		North	Antelope Valley	Mesozoic	Well	Moenkopi Fm			340	36.75081938	-112.8071472	No	USGS 2010b	Not in use 9/26/85
18	NWIS-2	364417112462901		B-39-05 36ADC		North	Antelope Valley	Mesozoic	Well	Holocene Alluvium			45	36.73804157	-112.7754788	Yes	USGS 2010b	
19	NWIS-2	365725112222301		B-41-01 14BCA		North	Kanab Plateau - North	Mesozoic	Well				150	36.95693109	-112.3738059	No	USGS 2010b	
20	NWIS-2	365713112233401		B-41-01 15CBA		North	Kanab Plateau - North	Mesozoic	Well	Moenkopi Fm			360	36.95359778	-112.3935288	Yes	USGS 2010b	
21	BLM_Field_Inv	BITT-WELL		Bitter Seeps Well; B-39-03 06AB		North	Kanab Plateau - South	Mesozoic	Well				150	36.815722	-112.654495	Yes	BLM 2010d	
22	NWIS-2	364328113040501	1	Clayhole Well #1 (North); B-38-07 05ACC1		North	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm			25	36.72442936	-113.0688264	No	USGS 2010b	
22	BLM_Field_Inv	CLAY-W1	2	Clayhole Well #1 (North); B-38-07 5AC		North	Uinkaret Plateau - Central	Mesozoic	Well				25	36.72442936	-113.0688264	Yes	BLM 2010d	Hand dug with windmill
23	NWIS-2	364327113040601	1	Clayhole Well #2 (South); B-38-07 05ACC2		North	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm			25	36.72415158	-113.0691041	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
23	NURE	GCBD502R	2			North	Uinkaret Plateau - Central	Mesozoic	Well	QTRN				36.72388491	-113.069170811	Yes	USGS 2009b	
23	BLM_Field_Inv	CLAY-W2	3	Clayhole Well #2 (South); B-38-07 05AC		North	Uinkaret Plateau - Central	Mesozoic	Well				30	36.72415158	-113.0691041	Yes	BLM 2010d	Windmill
24	NWIS-2	364328113040801		B-38-07 05BDD		North	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm			23	36.72442936	-113.0696597	No	USGS 2010b	
25	NWIS-2	364127113023901	1	Old RCA Well; B-38-07 16DDB		North	Uinkaret Plateau - Central	Mesozoic	Well					36.6908179	-113.0449355	No	USGS 2010b	
25	NURE	GCBD501R	2			North	Uinkaret Plateau - Central	Mesozoic	Well	QTRN				36.690384562	-113.04466879	Yes	USGS 2009b	
26	NWIS-2	364117113043401		B-38-07 17CCC		North	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm			1780	36.68803996	-113.0768816	No	USGS 2010b	
27	NWIS-2	364019113040201		B-38-07 29ABB		North	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm			1115	36.67192867	-113.0679919	No	USGS 2010b	
28	NWIS-2	363902113022601	1	Black Point Windmill; B-38-07 34CBB		North	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm				36.6505396	-113.041323	No	USGS 2010b	
28	BLM_Field_Inv	BLKPT-WELL	2	Black Point Windmill; B-38-07 34CB		North	Uinkaret Plateau - Central	Mesozoic	Well					36.6505396	-113.041323	Yes	USGS 2010b	
29	NWIS-2	364841113005401		B-39-07 02B UNSURVEYED		North	Uinkaret Plateau - Central	Mesozoic	Well	Holocene Alluvium			4031	36.81137406	-113.0157693	No	USGS 2010b	
30	NWIS-2	364858112511601		B-39-05 05BAA		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr			57	36.8160966	-112.8552066	No	USGS 2010b	
31	NWIS-2	364817112523701		B-39-05 06CCA		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr			150	36.80470776	-112.8777073	No	USGS 2010b	
32	NWIS-2	364807112511201		B-39-05 08ABB		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr			100	36.80193005	-112.854095	No	USGS 2010b	
33	NWIS-2	364634112521001		B-39-05 18DCB		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr			45	36.7760968	-112.8702064	Yes	USGS 2010b	
34	NWIS-2	364813112532101	1	B-39-06 01DCC		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr			160	36.8035966	-112.88993	No	USGS 2010b	
34	NURE	GCAE514R	2			North	Yellowstone Mesa	Mesozoic	Well	TRSS				36.803085519	-112.88886335	Yes	USGS 2009b	
35	NWIS-2	364850112540001		B-39-06 02AAD		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr			202	36.8138743	-112.900764	Yes	USGS 2010b	
36	NWIS-2	364720112553901		B-39-06 10CDD		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr			145	36.7888744	-112.9282649	No	USGS 2010b	
37	NWIS-2	364742112532701		B-39-06 12CAA1		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr				36.79498556	-112.8915966	No	USGS 2010b	
38	NWIS-2	364740112532901		B-39-06 12CAA2		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr				36.79443	-112.8921522	No	USGS 2010b	
39	NWIS-2	364657112544701		B-39-06 14BC		North	Yellowstone Mesa	Mesozoic	Well	Holocene Alluvium			2303	36.78248558	-112.9138196	No	USGS 2010b	
40	NWIS-2	364702112544801		B-39-06 14BCA		North	Yellowstone Mesa	Mesozoic	Well	Shinarump Mbr				36.78387446	-112.9140975	No	USGS 2010b	
41	BLM-Legacy	LEG-138	1	Clearwater Spring; B-39-03 21AB		North	Kanab Creek - Central	Perched	Spring		Perennial			36.77161	-112.61696	Yes	BLM 2010d	Possible Two Sources of Water Flow
41	NWIS-2	364606112371201	2	Clearwater Spring; B-39-03 21BDD		North	Kanab Creek - Central	Perched	Spring	Kaibab Ls				36.7683206	-112.6207512	Yes	USGS 2010b	
41	SIR-2010-5025	364606112371201	3	Clearwater Spring; B-39-03 21BDD		North	Kanab Creek - Central	Perched	Spring					36.769972	-112.620083	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
42	BLM-Legacy	LEG-93		Water Canyon Seep #3; B-38-03 05DA		North	Kanab Creek - Central	Perched	Spring					36.7211389	-112.631242	Yes	BLM 2010d	
43	BLM-Legacy	LEG-92		Water Canyon Seep #2; B-38-03 05DA		North	Kanab Creek - Central	Perched	Spring		Intermittent			36.722033	-112.63437	Yes	BLM 2010d	Dry at Time of Inventory/No Flow
44	BLM-Legacy	LEG-95	1	Upper Water Canyon Spring; B-38-03 05AC		North	Kanab Creek - Central	Perched	Spring		Perennial			36.72327	-112.6352	Yes	BLM 2010d	
44	BLM-Legacy	LEG-91	2	Water Canyon Seep #1; B-38-03 05DA		North	Kanab Creek - Central	Perched	Spring					36.72327	-112.6352	Yes	BLM 2010d	
45	BLM-Legacy	LEG-94		Lower Water Canyon Spring; B-38-03 04CB		North	Kanab Creek - Central	Perched	Spring		Perennial			36.72092	-112.62714	Yes	BLM 2010d	Good Relict Area/No Cattle Use
46	BLM-Legacy	LEG-60		Bessie Spring Lower; B-36-04 24AC		North	Kanab Creek - Lower	Perched	Spring					36.50661	-112.6755	Yes	BLM 2010d	Area of Both Upper and Lower Bessie Spring Unsurveyed/7.5 Not Available
47	BLM-Legacy	LEG-58		Bessie Spring Upper; B-36-04 23DD		North	Kanab Creek - Lower	Perched	Spring		Perennial			36.5021	-112.68322	Yes	BLM 2010d	Preston Allotment #5224 Kanab Gulch
48	BLM-Legacy	LEG-68	1	Grama Spring; B-37-03 19CBC		North	Kanab Plateau - South	Perched	Spring		Perennial			36.58928	-112.66362	Yes	BLM 2010d	20' of 2" Pipe Pvc Feeds Two Troughs:1)300 Gal, 2)500 Gal
48	NWIS-2	363521112394601	2	Grama Spring; B-37-03 19 UNSURVEYED		North	Kanab Plateau - South	Perched	Spring	Holocene Alluvium				36.5891516	-112.6635274	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
49	BLM-Legacy	LEG-69	1	Willow Spring; B-37-04 33BC		North	Kanab Plateau - South	Perched	Spring		Perennial			36.56595	-112.73593	Yes	BLM 2010d	Water Piped from Dugout Area to Nearby Cement Trough 10’×4’×1.5”
49	SIR-2010-5025	363357112440801	2	Willow Spring; B-37-04 33 UNSURVEYED		North	Kanab Plateau - South	Perched	Spring					36.565861	-112.735944	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - Reclaimed Mine Area (Pigeon Mine on East and Hack and Hermit Mines on West)
49	NWIS-2	363357112440801	3	Willow Spring; B-37-04 33 UNSURVEYED		North	Kanab Plateau - South	Perched	Spring					36.56581779	-112.736308	Yes	USGS 2010b	
49	D&M-85	Willow-Sp	4	Willow Spring		North	Kanab Plateau - South	Perched	Spring					36.56581779	-112.736308	Yes	Dames & Moore 1985	Data from Unpublished? Report Provided By Blm for Quarterly Sampling Conducted in 1983
49	EFN-90a	Pinenut-Willow	5	Willow Springs		North	Kanab Plateau - South	Perched	Spring					36.565861	-112.735944	Yes	Energy Fuels Nuclear Inc. 1990a	Used coordinates from SIR2010-5025 for Willow Spring
50	BLM-Legacy	LEG-57		South Water Canyon Spring; B-36-04 07AA		North	Kanab Plateau - South	Perched	Spring		Perennial			36.5399	-112.75583	Yes	BLM 2010d	Cement Dam in Front of 20’ Tunnel/Pipe from Dam to Trough: 3’×7’×1’
51	BLM-Legacy	LEG-59		Unnamed seep (South Water Canyon); B-36-04 07C		North	Kanab Plateau - South	Perched	Spring		Ephemeral			36.532798895	-112.7668668	Yes	BLM 2010d	Water Canyon Pasture Heaton Cattle Co.,Allotment #5221:Instream 95%,Wildlife 5%,Total Flow<0.1 Gallons per Minute/Wet Area:W=6’ L-12”/ Distchlus,Elymus,Chryso,Atca
52	BLM-Legacy	LEG-70		Buck Pasture Spring; B-37-05 15BC		North	Kanab Plateau - South	Perched	Spring		Intermittent			36.60715	-112.82534	Yes	BLM 2010d	Spring Dry at Time of Inspection/ Signs of Development at One Tome/Severe Disrepair/Jdr Description:Tunnel 40’×6’×4’ with 100’ of 1 1/2 Pipe to Wooden Trough 14’×20”×14”
53	BLM-86	WaterCyn-Seep		Small seep at confluence of Water and Hack’s Canyon		North	Kanab Plateau - South	Perched	Spring	Supai Fm. (Esplanade)				36.5612	-112.75794	No	BLM 1986	Described as being 4.6 miles North of Pinenut Mine, at Water Canyon entrance
54	NWIS-2	364327112303101	1	Pigeon Spring; B-38-02 04ACA		North	Snake Gulch	Perched	Spring	Kaibab Ls				36.7241547	-112.5093567	No	USGS 2010b	
54	Hopkins-84b	KAN003W	2	Pigeon Spring		North	Snake Gulch	Perched	Spring					36.724154743	-112.50935673	Yes	Hopkins et al. 1984b	
54	GCWC-02-Map	M-387	3	Pigeon Spring; B-38-02 04A		North	Snake Gulch	Perched	Spring					36.72427	-112.50925	No	Grand Canyon Wildlands Council 2002	
55	GCWC-02-Map	M-388		B-38-02 03		North	Snake Gulch	Perched	Spring					36.7224	-112.49496	No	Grand Canyon Wildlands Council 2002	No Spring on Topo
56	NWIS-2	363526112550501		B-37-06 22D UNSURVEYED		North	Antelope Valley	Perched	Well				700	36.59053935	-112.9188164	No	USGS 2010b	
57	NWIS-2	365120112174301		A-40-01 21ACB		North	Kanab Plateau - North	Perched	Well	Kaibab Ls			693	36.85554447	-112.29602	No	USGS 2010b	
58	NWIS-2	365416112181701		A-41-01 33CCC		North	Kanab Plateau - North	Perched	Well	Kaibab Ls			610	36.90443229	-112.3054673	No	USGS 2010b	
59	NWIS-2	364632112261001		Cedar Knoll (East); B-39-01 18DDB		North	Kanab Plateau - North	Perched	Well	Kaibab Ls			690	36.7755446	-112.4368555	Yes	USGS 2010b	
60	NWIS-2	364607112233001		B-39-01 22BCA		North	Kanab Plateau - North	Perched	Well				523	36.76860077	-112.3924088	No	USGS 2010b	
61	NWIS-2	364540112315501		Miller Well; B-39-02 20CDD		North	Kanab Plateau - North	Perched	Well	Coconino Ss			750	36.75915487	-112.5332475	No	USGS 2010b	
62	NWIS-2	364550112401201	1	Burnt Canyon Well; B-39-04 24DBD		North	Kanab Plateau - North	Perched	Well	Kaibab Ls			400	36.76387575	-112.6707529	Yes	USGS 2010b	
62	SIR-2010-5025	364550112401201	2	Burnt Canyon Well; B-39-04 24DBD		North	Kanab Plateau - North	Perched	Well					36.763472	-112.670083	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
63	NWIS-2	363905112462501	1	Tom Land Well; B-38-05 36ADD		North	Kanab Plateau - South	Perched	Well	Kaibab Ls			470	36.651374	-112.7743665	No	USGS 2010b	
63	SIR-2010-5025	363905112462601	2	Tom Land Well; B-38-04 25		North	Kanab Plateau - South	Perched	Well					36.651278	-112.774028	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
64	D&M-87	Hunt5-Well		Hunt #5; 55-503919 (at Hermit Mine)		North	Kanab Plateau - South	Perched	Well	Toroweap Fm			660	36.689638493	-112.751931988	Yes	Dames & Moore 1987b	
65	D&M-87	Kanab6-Well		Kanab #6; 55-509198		North	Kanab Creek - Central	Regional	Well	Redwall Ls			2700	36.689055789	-112.644278075	Yes	Dames & Moore 1987b	
66	D&M-87	Hack10-Well	1	Hack #10; 55-640855		North	Kanab Plateau - South	Regional	Well	Supai/Redwall			1475	36.584829762	-112.798901564	Yes	Dames & Moore 1987b	
66	D&M-85	Hack-Well	2	Hack Mine Well		North	Kanab Plateau - South	Regional	Well					36.584829762	-112.798901564	Yes	Dames & Moore 1985	Data from Unpublished? Report Provided By Blm for Quarterly Sampling Conducted in 1983
67	NWIS-2	364123112450501	1	Hermit Well; B-38-04 17CCA		North	Kanab Plateau - South	Regional	Well	Suprise Canyon Fm			3030	36.6897078	-112.7521437	No	USGS 2010b	
67	EFN-90b	Hermit-Well	2	Hermit Mine Monitoring Well		North	Kanab Plateau - South	Regional	Well	Redwall Ls				36.6891666667	-112.7511111111	Yes	Energy Fuels Nuclear Inc. 1990b	
67	EFN-90c	Hermit-Well	3	Hermit Mine Monitoring Well		North	Kanab Plateau - South	Regional	Well	Redwall Ls				36.6891666667	-112.7511111111	Yes	Energy Fuels Nuclear Inc. 1990c	
67	IUC-99	Hermit-Well	4	Hermit Mine Monitoring Well		North	Kanab Plateau - South	Regional	Well	Redwall Ls				36.6891666667	-112.7511111111	Yes	International Uranium Corp. 1999	
68	EFN-95a	Pinenut-Well	1	Pinenut Mine Monitor Well		North	Kanab Plateau - South	Regional	Well	Redwall Ls				36.5035510163	-112.734575	Yes	Energy Fuels Nuclear Inc. 1995a	No Location Reported, Used Location for Well 55-513394
68	SIR-2010-5025	363003112440901	2	Pinenut Well; B-36-04 10		North	Kanab Plateau - South	Regional	Well	Redwall Ls				36.503611	-112.799278	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
69	D&M-87	Pigeon4-Well	1	Pigeon #4; 55-503711		North	Snake Gulch	Regional	Well	Redwall Ls			2350	36.728590192	-112.530070407	Yes	Dames & Moore 1987b	
69	D&M-85	Pigeon-Well	2	Pigeon Mine Well		North	Snake Gulch	Regional	Well					36.728590192	-112.530070407	Yes	Dames & Moore 1985	Data from Unpublished? Report Provided By Blm for Quarterly Sampling Conducted in 1983
70	EFN-95b	Hermit-Shaft		Hermit Mine Shaft		North	Kanab Plateau - South	Mine seepage	Shaft	Breccia				36.6891666667	-112.7511111111	Yes	Energy Fuels Nuclear Inc. 1995b	No Location Reported, Given Lat/Long of Well Hermit Mine Monitor Well
71	CES-91	Hermit-Sump		Hermit Mine Sump		North	Kanab Plateau - South	Mine seepage	Sump	Breccia				36.6891666667	-112.7511111111	Yes	Canonie Environmental Services Corp. 1991	No Location Reported, Given Lat/Long of Well Hermit Mine Monitor Well
72	D&M-85	Hack2-Sump		Hack Canyon #2 Mine Water		North	Kanab Plateau - South	Mine seepage	Sump					36.58219	-112.81059	Yes	Dames & Moore 1985	
73	D&M-87	Pigeon-Sump		Pigeon Mine Main Sump		North	Snake Gulch	Mine seepage	Sump					36.7303996889	-112.5308169806	Yes	Dames & Moore 1987b	No Location Reported, Assigned Location of Pigeon #4 Well
74	EFN-88b	SW-KC4		Kanab Creek Downstream from Kanab North Mine		North	Kanab Creek - Central	N/A	Stream					36.67967	-112.63296	Yes	Energy Fuels Nuclear 1988b	
75	EFN-88b	SW-KC5		Kanab Creek Upstream from Kanab North Mine		North	Kanab Creek - Central	N/A	Stream					36.68993	-112.62989	Yes	Energy Fuels Nuclear 1988b	
76	EFN-88b	SW-KC6		Kanab Creek Downstream from Clearwater Spring		North	Kanab Creek - Central	N/A	Stream					36.7698	-112.62076	Yes	Energy Fuels Nuclear 1988b	
77	EFN-88b	SW-KC2		Kanab Creek Upstream from Hack Canyon		North	Kanab Creek - Lower	N/A	Stream					36.56195	-112.64723	Yes	Energy Fuels Nuclear 1988b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
78	NWIS-2	364644112544101		B-39-06 14CAC		North	Yellowstone Mesa	N/D	Well					36.77887449	-112.9121528	No	USGS 2010b	
79	NWIS-2	365338112394501	1	Sand Spring; B-40-03 06CBC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Moenkopi Fm				36.89387477	-112.6632573	No	USGS 2010b	
79	GCWC-02-Map	M-449	2	Sand Spring; B-40-03 06C		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.89371	-112.6629	No	Grand Canyon Wildlands Council 2002	
80	NWIS-2	365142112344901	1	Quick Water Spring; B-40-03 14DAC UNSURVEYED		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Moenkopi Fm				36.86165347	-112.5810313	No	USGS 2010b	
80	GCWC-02-Map	M-450	2	Quick Water Spring; B-40-03 14DCC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.86151	-112.58107	No	Grand Canyon Wildlands Council 2002	
81	GCWC-02-Map	M-451	1	Two Mile Seep; B-40-03 19CCD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.84676	-112.66112	No	Grand Canyon Wildlands Council 2002	
81	NWIS-2	365047112394201	2	B-40-03 19CCD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Moenkopi Fm				36.84637516	-112.6624222	No	USGS 2010b	
82	GCWC-02-Map	M-131	1	B-40-04 04A (seep)		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.89903	-112.72198	No	Grand Canyon Wildlands Council 2002	
82	NWIS-2	365353112431201	2	B-40-04 04ADD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Quaternary Alluvium				36.89804098	-112.720759	No	USGS 2010b	
83	GCWC-02-Map	M-467	1	Sixmile Spring; B-41-03 12CCC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.96233	-112.57558	No	Grand Canyon Wildlands Council 2002	
83	NWIS-2	365747112343001	2	B-41-03 12CCB UNSURVEYED		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr				36.96304145	-112.5757576	No	USGS 2010b	
83	NURE	GCAF502R	3			North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	TRSS Clastics - Coarse				36.962285893	-112.576457553	Yes[3]	USGS 2009b	
84	GWSI-1	365452112453901	1	Sheep Dip Spring; B-41-04 31ABD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Navajo Ss	Perennial	Fracture and Depression		36.914429068	-112.761593828	No	ADWR 2009b	
84	NWIS-2	365452112453901	2	B-41-04 31ABD2		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Navajo Ss				36.9144295	-112.7615942	No	USGS 2010b	
85	NWIS-2	365424112442901		B-41-04 32DDB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring	Quaternary Alluvium				36.90665187	-112.7421488	No	USGS 2010b	
86	NWIS-2	365215112442501		Pipe Springs		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.8708333	-112.7402778	No	USGS 2010b	
87	NWIS-2	365308112472301		Wooley Spring		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.88554077	-112.7904834	No	USGS 2010b	
88	GCWC-02-Map	M-183	1	Wooley Spring; B-40-05 12DB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.88096	-112.78097	No	Grand Canyon Wildlands Council 2002	
88	NURE	GCAE517R	2			North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.881085257	-112.78116065	Yes[3]	USGS 2009b	
89	GCWC-02-Map	M-458		Meeks Spring; B-41-05 34CD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.90375	-112.8247	No	Grand Canyon Wildlands Council 2002	
90	GCWC-02-Map	M-175		Upper Moccasin Springs; B-41-05 35ABB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.91541	-112.80287	No	Grand Canyon Wildlands Council 2002	
91	GCWC-02-Map	M-477		Upper Moccasin Spring; B-41-05 35ADD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.91237	-112.79726	No	Grand Canyon Wildlands Council 2002	
92	GCWC-02-Map	M-453		South Moccasin Seep; B-40-04 04B		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.90053	-112.73352	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
93	GCWC-02-Map	M-454		B-40-04 05		North Buffer	Kaibab Paiute Reservation	Mesozoic	Spring					36.89668	-112.74663	No	Grand Canyon Wildlands Council 2002	No Spring on Topo
94	BLM-Legacy	LEG-252	1	Johnson Spring; A-42-01 31DD		North Buffer	Kanab Plateau - North	Mesozoic	Spring					36.9908	-112.32415	No	BLM 2010d	Flow Rate Undetermined Due to Plugged Line (01-10-83)
94	NURE	GCAG501R	2			North Buffer	Kanab Plateau - North	Mesozoic	Spring	MNKP Sh				36.989586082	-112.324149918	Yes	USGS 2009b	
95	BLM-Legacy	LEG-225		Cow Seep; B-41-02 01AB		North Buffer	Kanab Plateau - North	Mesozoic	Spring					36.98753	-112.45672	Yes	BLM 2010d	No Measurement of Seep/Dry at Time of Inventory (07-31-85)/ Old Rusted 1" Steel Pipe for 100 Yards,Broken Up
96	BLM-Legacy	LEG-254		Juniper Seep; B-42-02 36CA		North Buffer	Kanab Plateau - North	Mesozoic	Spring					36.99213	-112.46223	Yes	BLM 2010d	Seep Dry at Time of Inventory (07-31-85)/No Flow Measured/ Undeveloped
97	BLM-Legacy	LEG-226		Shinarump Seep; B-41-02 01BBA		North Buffer	Kanab Plateau - North	Mesozoic	Spring					36.98981	-112.45965	Yes	BLM 2010d	Permittee:Judd/Seep Flow 0.05/1" Pipe to Drain Tunnel Pool 1/2" Used to Drain Middle--Both Long Since Destroyed
98	BLM-Legacy	LEG-253		B-42-02 36DB (seep)		North Buffer	Kanab Plateau - North	Mesozoic	Spring					36.91268	-112.46035	Yes	BLM 2010d	Seep=Damp/No Flow Measured/100% Instream
99	NHD-1	78328951				North Buffer	Kanab Plateau - North	Mesozoic	Spring					37.0114110092	-112.422708869	No	USGS 2007	
100	NHD-1	78328967				North Buffer	Kanab Plateau - North	Mesozoic	Spring					37.0318954759	-112.268100803	No	USGS 2007	
101	GWSI-1	365149112442201	1	Pipe Spring; B-40-04 17DDB		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss	Perennial	Fracture		36.863124516	-112.740341567	Yes	ADWR 2009b	
101	NWIS-2	365149112442201	2	B-40-04 17DDB		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss				36.8635966	-112.740203	Yes	USGS 2010b	
101	GCWC-02	PSNM-2	3	Pipe (Fort) Spring; B-40-04 17DD		North Buffer	Moccasin Mtns	Mesozoic	Spring	Chinle Fm		Fault		36.86311	-112.73964	Yes	Grand Canyon Wildlands Council 2002	Central Arizona Strip, Northern Edge, in Pipe Springs National Monument
102	NWIS-2	365149112442202		B-40-04 17DDB2		North Buffer	Moccasin Mtns	Mesozoic	Spring					36.8635966	-112.740203	Yes	USGS 2010b	
103	NWIS-2	365149112442203		B-40-04 17DDB3		North Buffer	Moccasin Mtns	Mesozoic	Spring					36.8635966	-112.740203	Yes	USGS 2010b	
104	GWSI-1	365438112453501	1	Long Res Spring; B-41-04 31ADC		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss	Perennial	Fracture		36.910541099	-112.760482673	Yes	ADWR 2009b	
104	NWIS-2	365438112453501	2	B-41-04 31ADC		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss				36.91054066	-112.7604829	Yes	USGS 2010b	
105	GWSI-1	365435112460301	1	Mocassin Spring; B-41-04 31CAB		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss	Perennial	Fracture		36.909707092	-112.768260949	Yes	ADWR 2009b	
105	NWIS-2	365435112460301	2	B-41-04 31CAB		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss				36.9097073	-112.7682609	No	USGS 2010b	
106	GCWC-02-Map	M-473	1	Moccasin Spring; B-41-04 31DBB		North Buffer	Moccasin Mtns	Mesozoic	Spring					36.91008	-112.7631	No	Grand Canyon Wildlands Council 2002	
106	GWSI-1	365436112454501	2	Sand Spring; B-41-04 31DBA		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss	Perennial	Fracture		36.909985097	-112.763260764	No	ADWR 2009b	
106	NWIS-2	365436112454501	3	B-41-04 31DBA2		North Buffer	Moccasin Mtns	Mesozoic	Spring	Navajo Ss				36.9099851	-112.7632608	Yes	USGS 2010b	
106	NURE	GCAE508R	4			North Buffer	Moccasin Mtns	Mesozoic	Spring	TRSS Ss				36.909385106	-112.761560681	Yes	USGS 2009b	
107	NWIS-2	365433112461001		Upper Moccasin unnamed spring		North Buffer	Moccasin Mtns	Mesozoic	Spring					36.90915176	-112.7702055	No	USGS 2010b	
108	GCWC-02	PSNM-1		West Cabin Spring; B-40-04 17DD		North Buffer	Moccasin Mtns	Mesozoic	Spring	Chinle Fm	Perennial	Fault		36.86322	-112.74023	Yes	Grand Canyon Wildlands Council 2002	Central Arizona Strip, Northern Edge, in Pipe Springs National Monument

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
109	GCWC-02	PSNM-3		Tunnel Spring; B-40-04 17DD		North Buffer	Moccasin Mtns	Mesozoic	Spring	Chinle Fm	Perennial	Fault		36.86311	-112.73964	Yes	Grand Canyon Wildlands Council 2002	Central Arizona Strip, Northern Edge, in Pipe Springs National Monument
110	NHD-1	78328767				North Buffer	Moccasin Mtns	Mesozoic	Spring					36.8874286761	-112.859930469	No	USGS 2007	
111	NHD-1	78328733				North Buffer	Moccasin Mtns	Mesozoic	Spring					36.8917288094	-112.863311869	No	USGS 2007	
112	NHD-1	126746163				North Buffer	Moccasin Mtns	Mesozoic	Spring					36.9035566761	-112.847525402	No	USGS 2007	
113	GCWC-02-Map	M-79		B-39-08 05ABB		North Buffer	Uinkaret Plateau - Central	Mesozoic	Spring					36.81817	-113.17721	No	Grand Canyon Wildlands Council 2002	
114	GCWC-02-Map	M-478		B-41-06 03		North Buffer	Uinkaret Plateau - North	Mesozoic	Spring					36.89658	-112.92687	No	Grand Canyon Wildlands Council 2002	No Spring on Topo
115	GWSI-1	362457113080001	1	Coyote Spring; B-35-08 22DBD		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows	Perennial	Contact		36.415814435	-113.134100092	Yes	ADWR 2009b	
115	NWIS-2	362457113080001	2	B-35-08 22DBD		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows				36.41581477	-113.1341004	No	USGS 2010b	
115	BLM-Legacy	LEG-43	3	Coyote Spring; B-35-08 22D		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring					36.41568	-113.13422	No	BLM 2010d	Flow Not Available/Piped to House
116	GWSI-1	362408113084601	1	Nixon Spring; B-35-08 27CBC		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows	Perennial	Contact		36.402203357	-113.146878325	Yes	ADWR 2009b	
116	NWIS-2	362408113084601	2	B-35-08 27CBC		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows				36.40220358	-113.1468784	No	USGS 2010b	
116	GCWC-02	BLM 187	3	Nixon Spring; B-35-08 27CB		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	Basalt	Perennial	Contact; Fracture		36.4022	-113.14653	Yes	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, South Slope of Mt. Trumbull
116	BLM-Legacy	LEG-44	4	Nixon Spring; B-35-08 27CB		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring					36.4022	-113.14653	Yes	BLM 2010d	Flow Was 5.56 Gallons per Minute on 05-01-85/Source Location-Langs Run
117	NURE	GCCD501R				North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	UNKN Volcanics -Mafic				36.392481318	-113.151767281	Yes	USGS 2009b	
118	BLM-Legacy	LEG-45		Orson Spring; B-35-08 23CDB		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring					36.41392	-113.12228	Yes	BLM 2010d	Spring Completely Buried at Source
119	GCWC-02-Map	M-44		Hualpais Spring; B-37-08 31		North Buffer	Uinkaret Plateau - South	Mesozoic	Spring					36.56488	-113.20001	No	Grand Canyon Wildlands Council 2002	
120	NHD-1	78329017				North Buffer	Vermilion Cliffs (UT)	Mesozoic	Spring					37.0500028092	-112.438913203	No	USGS 2007	
121	NHD-1	78328991				North Buffer	Vermilion Cliffs (UT)	Mesozoic	Spring					37.0574402758	-112.477864469	No	USGS 2007	
122	NWIS-2	365913112314501		B-41-02 05ABC		North Buffer	Fredonia, AZ	Mesozoic	Well				770	36.98693039	-112.5299242	No	USGS 2010b	
123	NWIS-2	365920112320001		B-41-02 05BAB		North Buffer	Fredonia, AZ	Mesozoic	Well				400	36.98887479	-112.534091	No	USGS 2010b	
124	NWIS-2	365856112332401		B-41-02 06CBB		North Buffer	Fredonia, AZ	Mesozoic	Well	Shinarump Mbr			220	36.98220805	-112.5574246	Yes	USGS 2010b	
125	NWIS-2	365752112310001		B-41-02 09CDB		North Buffer	Fredonia, AZ	Mesozoic	Well	Moenkopi Fm			895	36.9644307	-112.5174229	No	USGS 2010b	
126	NWIS-2	370001112313701		B-42-02 32ACA		North Buffer	Fredonia, AZ	Mesozoic	Well	Moenkopi Fm			225	37.0002636	-112.5277025	No	USGS 2010b	
127	NWIS-2	370000112320201		B-42-02 32BDB		North Buffer	Fredonia, AZ	Mesozoic	Well	Moenkopi Fm			196	36.99998578	-112.534647	Yes	USGS 2010b	
128	NURE	CDDF503R				North Buffer	Fredonia, AZ	Mesozoic	Well	QTRN				37.006485784	-112.527158149	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
129	NURE	GCAF501R				North Buffer	Fredonia, AZ	Mesozoic	Well	MNKP Ss				36.998185803	-112.534558104	Yes	USGS 2009b	
130	NWIS-2	365408112441201		B-40-04 04BBC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Holocene Alluvium			128	36.90220749	-112.7374263	No	USGS 2010b	
131	NWIS-2	365347112444301		B-40-04 05ACC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Shinarump Mbr			99	36.8963741	-112.7460375	Yes[3]	USGS 2010b	
132	NWIS-2	365400112444801		B-40-04 05BDA		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Holocene Alluvium			60	36.8999852	-112.7474266	No	USGS 2010b	
133	NWIS-2	365339112445201		B-40-04 05CAD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Chinle Fm			238	36.8941519	-112.7485375	No	USGS 2010b	
134	NWIS-2	365325112445201		B-40-04 05CDD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Navajo Ss			205	36.89026305	-112.7485374	Yes[3]	USGS 2010b	
135	NWIS-2	365403112452801		B-40-04 06AAC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Kayenta Fm			202	36.9008185	-112.758538	Yes[3]	USGS 2010b	
136	NWIS-2	365324112445501		B-40-04 08BAB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Navajo Ss			155	36.88998527	-112.7493708	Yes[3]	USGS 2010b	
137	NWIS-2	365310112422501		B-40-04 10ACA		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Holocene Alluvium			100	36.8860967	-112.7077027	No	USGS 2010b	
138	NWIS-2	365310112422801		B-40-04 10ACB		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Moenkopi Fm			100	36.8860967	-112.708536	No	USGS 2010b	
139	NWIS-2	365209112415101		B-40-04 14BCD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Holocene Alluvium			46	36.86915247	-112.6982575	No	USGS 2010b	
140	NWIS-2	365236112442501		B-40-04 17ACC		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well				200	36.87665209	-112.7410368	Yes[3]	USGS 2010b	
141	NWIS-2	365452112454201		B-41-04 31ABD1		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Holocene Alluvium			110	36.9144295	-112.7624275	No	USGS 2010b	
142	NWIS-2	365446112464001		B-41-04 31ACA		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well	Holocene Alluvium			70	36.9127628	-112.7785392	No	USGS 2010b	
143	NWIS-2	365412112452401		B-41-04 31DDD		North Buffer	Kaibab Paiute Reservation	Mesozoic	Well				65	36.90331849	-112.757427	No	USGS 2010b	
144	NWIS-2	372012112221502		C-43-05 25CDB2		North Buffer	Kanab Plateau - North	Mesozoic	Well	Valley Fill				37.0394297	-112.3715862	Yes	USGS 2010b	
145	NWIS-2	370050112274501	1	C-44-05 06CBB1		North Buffer	Kanab Plateau - North	Mesozoic	Well				80	37.0138747	-112.4632562	Yes	USGS 2010b	
145	NURE	CDDG501R	2			North Buffer	Kanab Plateau - North	Mesozoic	Well	QTRN				37.013585831	-112.46465625	Yes	USGS 2009b	
146	NWIS-2	365508112270001		B-41-02 25DDD		North Buffer	Kanab Plateau - North	Mesozoic	Well	Moenkopi Fm			210	36.9188759	-112.4507517	No	USGS 2010b	
147	NWIS-2	365440112454101		B-41-04 31ACD		North Buffer	Moccasin Mtns	Mesozoic	Well	Navajo Ss			80	36.9110962	-112.7621496	Yes	USGS 2010b	
148	NWIS-2	365435112453701		B-41-04 31DAB		North Buffer	Moccasin Mtns	Mesozoic	Well	Holocene Alluvium			80	36.9097073	-112.7610384	No	USGS 2010b	
149	NWIS-2	365433112454501		B-41-04 31DBA1		North Buffer	Moccasin Mtns	Mesozoic	Well	Holocene Alluvium			120	36.90915177	-112.7632607	No	USGS 2010b	
150	NWIS-2	365435112455501		B-41-04 31DBB		North Buffer	Moccasin Mtns	Mesozoic	Well					36.9097073	-112.7660386	Yes	USGS 2010b	
151	NWIS-2	365424112453401		B-41-04 31DDB		North Buffer	Moccasin Mtns	Mesozoic	Well	Holocene Alluvium			95	36.90665179	-112.760205	No	USGS 2010b	
152	NWIS-2	365436112451801		B-41-04 32CBB		North Buffer	Moccasin Mtns	Mesozoic	Well				120	36.9099851	-112.7557605	No	USGS 2010b	
153	NWIS-2	364843113101801		B-39-08 05ADB		North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm			202	36.8119291	-113.1724438	Yes	USGS 2010b	
154	NWIS-2	364837113101801	1	B-39-08 05DBA		North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm			20	36.81026247	-113.1724438	No	USGS 2010b	
154	NURE	GCAD510R	2			North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	TRSS Carbonate				36.809684694	-113.172777152	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
155	NWIS-2	364747113070101		B-39-08 11ADC		North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm				36.79637379	-113.1177187	No	USGS 2010b	
156	NWIS-2	364528113080901	1	B-39-08 27AAB		North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	Moenkopi Fm				36.7577627	-113.1366084	No	USGS 2010b	
156	NURE	GCAD512R	2			North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	TRSS Ss				36.756184959	-113.135774999	Yes	USGS 2009b	
157	NWIS-2	364528113101401		B-39-08 29AA		North Buffer	Uinkaret Plateau - Central	Mesozoic	Well				20.4	36.75776259	-113.1713325	No	USGS 2010b	
158	NURE	GCAD511R				North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	TRSS Ss				36.79658488	-113.125174678	Yes	USGS 2009b	
159	NWIS-2	365049112514501	1	B-40-05 20CCC		North Buffer	Uinkaret Plateau - North	Mesozoic	Well					36.84692975	-112.8632632	No	USGS 2010b	
159	NURE	GCAE502R	2			North Buffer	Uinkaret Plateau - North	Mesozoic	Well	TRSS				36.84728531	-112.862463159	Yes	USGS 2009b	
160	NWIS-2	365049112502601		B-40-05 21CCD		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Shinarump Mbr				36.8469298	-112.8413178	No	USGS 2010b	
161	NWIS-2	365241112534901		B-40-06 12CCB		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Navajo Ss			2202	36.8780406	-112.8977097	No	USGS 2010b	
162	NWIS-2	365138112560801		B-40-06 21AAA		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Shinarump Mbr			265	36.8605406	-112.936322	No	USGS 2010b	
163	NWIS-2	365050112545501		B-40-06 23CCC		North Buffer	Uinkaret Plateau - North	Mesozoic	Well				257	36.8472074	-112.9160432	No	USGS 2010b	
164	NWIS-2	365059112541101		B-40-06 23DCA		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Chinle Fm				36.8497074	-112.9038205	No	USGS 2010b	
165	NWIS-2	365044112545501		B-40-06 26BBB		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Shinarump Mbr			250	36.84554076	-112.9160432	No	USGS 2010b	
166	NWIS-2	365043112572301	1	B-40-06 29AAB		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Shinarump Mbr			260	36.8452629	-112.957156	No	USGS 2010b	
166	NURE	GCAE501R	2			North Buffer	Uinkaret Plateau - North	Mesozoic	Well	TRSS Volcanics - Mafic				36.844785127	-112.957667155	Yes	USGS 2009b	
167	NWIS-2	365020112584501		B-40-06 30		North Buffer	Uinkaret Plateau - North	Mesozoic	Well				296	36.838874	-112.9799347	No	USGS 2010b	
168	NWIS-2	365046112582001		B-40-06 30AAA		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			290	36.8460962	-112.97299	Yes	USGS 2010b	
169	NWIS-2	364955112585201		B-40-06 31BAA		North Buffer	Uinkaret Plateau - North	Mesozoic	Well				451	36.83192959	-112.981879	No	USGS 2010b	
170	NWIS-2	364952112571401		B-40-06 32AAA		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Shinarump Mbr			300	36.8310963	-112.9546557	Yes	USGS 2010b	
171	NWIS-2	364951112570601		B-40-06 33BBB		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			300	36.83081855	-112.9524334	No	USGS 2010b	
172	NWIS-2	365327113033501		B-40-07 04CCC		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			300	36.890818	-113.0604946	Yes	USGS 2010b	
173	NWIS-2	365105113042501		B-40-07 20CAC		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			30	36.8513737	-113.0743837	No	USGS 2010b	
174	NWIS-2	365220113072201		B-40-08 14ABC		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm				36.87220688	-113.1235528	No	USGS 2010b	
175	NWIS-2	365150113103201	1	B-40-08 17DCB		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			16	36.86387346	-113.176333	Yes	USGS 2010b	
175	NURE	GCAD505R	2			North Buffer	Uinkaret Plateau - North	Mesozoic	Well	TRSS Carbonate				36.865184568	-113.176677508	Yes	USGS 2009b	
176	NWIS-2	365001113093801		B-40-08 28CDA		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			3753	36.83359578	-113.1613322	No	USGS 2010b	
177	NWIS-2	365003113110701		B-40-08 29CCC		North Buffer	Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			50	36.83415127	-113.1860557	No	USGS 2010b	
178	NURE	GCAD504R				North Buffer	Uinkaret Plateau - North	Mesozoic	Well	TRSS Ss				36.875984655	-113.117474809	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
179	GCWC-02-Map	M-76	1	Atkins Well; B-41-08 10BA		North Buffer	Uinkaret Plateau - North	Mesozoic	Well					36.88958	-113.14547	No	Grand Canyon Wildlands Council 2002	
179	NURE	GCAD506R	2			North Buffer	Uinkaret Plateau - North	Mesozoic	Well	TRSS Ss				36.890084566	-113.145176155	Yes	USGS 2009b	
180	NURE	GCAE510R				North Buffer	Uinkaret Plateau - North	Mesozoic	Well	TRSS				36.871584938	-112.97766842	Yes	USGS 2009b	
181	GCWC-02-Map	M-42	1	Hotel Spring; B-34-04 07A		North Buffer	150-mile Canyon	Perched	Spring					36.36401	-112.75762	No	Grand Canyon Wildlands Council 2002	
181	SIR-2010-5025	362157112451601	2	Hotel Spring; B-34-04 07 UNSURVEYED		North Buffer	150-mile Canyon	Perched	Spring					36.365972	-112.753639	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
181	NWIS-1	362157112451601	3	Hotel Spring		North Buffer	150-mile Canyon	Perched	Spring					36.36583333	-112.75444444	Yes	USGS 2009a	
182	GCWC-02-Map	M-309	1	Buckhorn Spring; B-34-05 01BA		North Buffer	150-mile Canyon	Perched	Spring					36.38236	-112.77933	No	Grand Canyon Wildlands Council 2002	
182	NWIS-1	362258112464701	2	Buckhorn Spring		North Buffer	150-mile Canyon	Perched	Spring					36.38277778	-112.77972222	Yes	USGS 2009a	
183	GCWC-02-Map	M-51		Little Joe Spring; B-34-04 06DDD		North Buffer	150-mile Canyon	Perched	Spring					36.36872	-112.75409	No	Grand Canyon Wildlands Council 2002	
184	GCWC-02-Map	M-105		B-34-04 08C		North Buffer	150-mile Canyon	Perched	Spring					36.35675	-112.748	No	Grand Canyon Wildlands Council 2002	
185	GCWC-02-Map	M-308		North Spring; B-35-04 34ADD		North Buffer	150-mile Canyon	Perched	Spring					36.39143	-112.7001	No	Grand Canyon Wildlands Council 2002	
186	GCWC-02-Map	M-336	1	Lower Jumpup Spring; B-36-03 11BD		North Buffer	Jumpup Canyon	Perched	Spring					36.53765	-112.58523	No	Grand Canyon Wildlands Council 2002	
186	SIR-2010-5025	363209112350801	2	Lower Jumpup Spring; B-36-03 11		North Buffer	Jumpup Canyon	Perched	Spring					36.532111	-112.586833	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
186	NWIS-1	363209112350801	3	Lower Jumpup Spring		North Buffer	Jumpup Canyon	Perched	Spring					36.53583333	-112.58555556	Yes	USGS 2009a	
187	SIR-2010-5025	363115112342601	1	Mountain Sheep Spring; B-36-03 13		North Buffer	Jumpup Canyon	Perched	Spring					36.52325	-112.567361	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
187	GCWC-02-Map	M-446	2	Mountain Sheep Spring; B-36-03 13BDB		North Buffer	Jumpup Canyon	Perched	Spring					36.52314	-112.56757	No	Grand Canyon Wildlands Council 2002	
188	SIR-2010-5025	363450112325001	1	Upper Jumpup Spring; B-37-02 30		North Buffer	Jumpup Canyon	Perched	Spring					36.58075	-112.546778	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
188	NWIS-1	363450112325001	2	Upper Jumpup Spring		North Buffer	Jumpup Canyon	Perched	Spring					36.58055556	-112.54722222	Yes	USGS 2009a	
189	NWIS-1	363115112342601				North Buffer	Jumpup Canyon	Perched	Spring					36.52083333	-112.57388889	Yes	USGS 2009a	
190	GCWC-02-Map	M-330		Bitter Spring; B-36-02 07C		North Buffer	Jumpup Canyon	Perched	Spring					36.52687	-112.55209	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
191	GCWC-02-Map	M-329		Cottonwood Spring; B-36-02 18AB		North Buffer	Jumpup Canyon	Perched	Spring					36.52602	-112.54557	No	Grand Canyon Wildlands Council 2002	
192	GCWC-02-Map	M-47		Indian Hollow Spring; B-36-03 25BDD		North Buffer	Jumpup Canyon	Perched	Spring					36.49181	-112.56599	No	Grand Canyon Wildlands Council 2002	Usgs Coordinates Listed as X="362051/362039.25" and Y="4037069/4037044.8"
193	GCWC-02-Map	M-33		Forgotten Canyon Spring; B-36-03 25		North Buffer	Jumpup Canyon	Perched	Spring					36.49067	-112.57161	No	Grand Canyon Wildlands Council 2002	
194	GCWC-02-Map	M-58		Lower Forgotten Canyon Spring; B-36-03 24		North Buffer	Jumpup Canyon	Perched	Spring					36.49046	-112.57426	No	Grand Canyon Wildlands Council 2002	
195	GCWC-02-Map	M-365		Jumpup Spring; B-37-02 30DBB		North Buffer	Jumpup Canyon	Perched	Spring					36.57686	-112.54879	No	Grand Canyon Wildlands Council 2002	
196	GCWC-02-Map	M-50		Kwagunt Hollow Spring; B-36-02 19		North Buffer	Jumpup Canyon	Perched	Spring					36.50193	-112.5477	No	Grand Canyon Wildlands Council 2002	
197	Springs_0103	INDHOL		Indian Hollow Spring		North Buffer	Jumpup Canyon	Perched	Spring					36.4706133069	-112.540571187	No	BLM 2010c	
198	GWSI-1	364143112184501	1	Warm Springs; A-38-01 17ACA		North Buffer	Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact		36.695267514	-112.31323707	Yes	ADWR 2009b	
198	GCWC-02	KNF-23	2	Warm Springs; A-38-01 17AC		North Buffer	Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact; Fracture		36.69539	-112.31275	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, Warm Springs Canyon, Five Miles West of Jacobs Lake
198	NWIS-2	364143112184501	3	A-38-01 17ACA		North Buffer	Kaibab Plateau	Perched	Spring	Coconino Ss				36.69526729	-112.313237	Yes	USGS 2010b	
198	NURE	GCBG503R	4			North Buffer	Kaibab Plateau	Perched	Spring	UNKN Ss				36.695289524	-112.311937017	Yes	USGS 2009b	
199	GCWC-02-Map	M-376		Oak Spring; A-38-01 19C		North Buffer	Kaibab Plateau	Perched	Spring					36.67567	-112.3367	No	Grand Canyon Wildlands Council 2002	
200	GCWC-02-Map	M-373		Tilton Springs; A-38-01 30CC		North Buffer	Kaibab Plateau	Perched	Spring					36.65881	-112.3388	No	Grand Canyon Wildlands Council 2002	
201	GCWC-02-Map	M-344		Moquitch Spring; A-37-01 06DA		North Buffer	Kaibab Plateau	Perched	Spring					36.63363	-112.32575	No	Grand Canyon Wildlands Council 2002	
202	BLM-Legacy	LEG-56		Daves Canyon Spring; B-36-03 30CC		North Buffer	Kanab Creek - Lower	Perched	Spring		Perennial			36.48655	-112.66276	Yes	BLM 2010d	Spring Flow Actually 0.26 Gallons per Minute
203	BLM-Legacy	LEG-40		B&H Spring; B-35-04 12AB		North Buffer	Kanab Creek - Lower	Perched	Spring					36.45347	-112.67153	Yes	BLM 2010d	No Access to Livestock,Only Wildlife/Located on Grand Canyon National Park
204	BLM-Legacy	LEG-42		Dripping Spring North; B-35-04 12CC		North Buffer	Kanab Creek - Lower	Perched	Spring		Intermittent			36.4434	-112.6753	Yes	BLM 2010d	Spring is Located Inside Grand Canyon National Park Boundary/ Estimated Flow Rate 0.75 Gallons per Minute/Average Could Be Perrinial Seep/No 7.5 Minute Quads for this Area/Us
205	BLM-Legacy	LEG-41		Dripping Spring South; B-35-04 13BB		North Buffer	Kanab Creek - Lower	Perched	Spring		Intermittent			36.43946	-112.67862	Yes	BLM 2010d	Sheep Use/Inside Grand Canyon National Park Boundary
206	GCWC-02-Map	M-63		Maidenhair Spring; B-36-03 18		North Buffer	Kanab Creek - Lower	Perched	Spring					36.52557	-112.65126	No	Grand Canyon Wildlands Council 2002	
207	GCWC-02-Map	M-180	1	Wildband Spring; B-38-02 04DC		North Buffer	Snake Gulch	Perched	Spring					36.71712	-112.51015	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
207	NWIS-2	364259112303201	2	Wildband Spring; B-38-02 04DCD		North Buffer	Snake Gulch	Perched	Spring	Kaibab Ls				36.71637678	-112.5096344	No	USGS 2010b	
207	Hopkins-84b	KAN002W	3	Wildband Spring		North Buffer	Snake Gulch	Perched	Spring					36.716932299	-112.510189905	Yes	Hopkins et al. 1984b	
208	GCWC-02-Map	M-158	1	Rock Spring; B-38-03 24BB		North Buffer	Snake Gulch	Perched	Spring					36.68363	-112.57341	No	Grand Canyon Wildlands Council 2002	
208	SIR-2010-5025	364101112340601	2	Rock Spring; B-38-03 24		North Buffer	Snake Gulch	Perched	Spring					36.683722	-112.571833	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - Reclaimed Mine Area (Pigeon Mine on East and Hack and Hermit Mines on West)
208	Hopkins-84b	KAN005W	3	Rock Spring		North Buffer	Snake Gulch	Perched	Spring					36.684431245	-112.571858434	Yes	Hopkins et al. 1984b	
209	GCWC-02-Map	M-53	1	Little Slide Spring; B-38-03 25		North Buffer	Snake Gulch	Perched	Spring					36.65803	-112.56238	No	Grand Canyon Wildlands Council 2002	
209	SIR-2010-5025	363922112334501	2	Slide Spring; B-38-03 36		North Buffer	Snake Gulch	Perched	Spring					36.658028	-112.561639	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - Reclaimed Mine Area (Pigeon Mine on East and Hack and Hermit Mines on West)
209	NWIS-1	363922112334501	3			North Buffer	Snake Gulch	Perched	Spring					36.65611111	-112.5625	Yes	USGS 2009a	
209	Hopkins-84b	KAN001W	4	Slide Spring		North Buffer	Snake Gulch	Perched	Spring					36.658042065	-112.562968644	Yes	Hopkins et al. 1984b	
210	GCWC-02-Map	M-170	1	Table Rock Spring; B-38-02 12B		North Buffer	Snake Gulch	Perched	Spring					36.71141	-112.46396	No	Grand Canyon Wildlands Council 2002	
210	Hopkins-84b	KAN004W	2	Table Rock Spring		North Buffer	Snake Gulch	Perched	Spring					36.711099366	-112.464354608	Yes	Hopkins et al. 1984b	
211	GCWC-02-Map	M-176	1	Upper Willow Spring; B-38-02 08AC		North Buffer	Snake Gulch	Perched	Spring					36.70996	-112.52865	No	Grand Canyon Wildlands Council 2002	
211	Hopkins-84b	KAN006W	2	Willow Spring		North Buffer	Snake Gulch	Perched	Spring					36.709432002	-112.529357212	Yes	Hopkins et al. 1984b	Name from 100K Topo Map
212	GCWC-02-Map	M-394		Horse Spring; B-38-03 36BDD		North Buffer	Snake Gulch	Perched	Spring					36.65078	-112.56984	No	Grand Canyon Wildlands Council 2002	
213	GCWC-02-Map	M-393		Slide Spring; B-38-03 25		North Buffer	Snake Gulch	Perched	Spring					36.66369	-112.56586	No	Grand Canyon Wildlands Council 2002	
214	GCWC-02-Map	M-367		Little Spring; B-37-03 03D		North Buffer	Snake Gulch	Perched	Spring					36.63283	-112.59612	No	Grand Canyon Wildlands Council 2002	
215	NHD-1	GNIS-00007196		Little Spring		North Buffer	Snake Gulch	Perched	Spring					36.6295680765	-112.585678669	No	USGS 2007	
216	GCWC-02-Map	M-161	1	Schmutz Spring; B-34-06 10DBB		North Buffer	Tuckup Canyon	Perched	Spring					36.36164	-112.91952	No	Grand Canyon Wildlands Council 2002	
216	SIR-2010-5025	362143112551201	2	Schmutz Spring; B-34-06 10 UNSURVEYED		North Buffer	Tuckup Canyon	Perched	Spring					36.362083	-112.919306	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - East Kanab, Unmined Area, Breccia Pipes Present
216	NWIS-1	362143112551201	3	Schmutz Spring		North Buffer	Tuckup Canyon	Perched	Spring					36.36194444	-112.92	Yes	USGS 2009a	
217	GCWC-02-Map	M-271		Cottonwood Spring; B-34-06 22D		North Buffer	Tuckup Canyon	Perched	Spring					36.33028	-112.91858	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
218	NWIS-2	365813112324901		B-41-02 07ACC		North Buffer	Fredonia, AZ	Perched	Well	Kaibab Ls			1400	36.97026378	-112.5477016	No	USGS 2010b	
219	NWIS-2	365427112283901		B-41-02 35CAD		North Buffer	Kanab Plateau - North	Perched	Well	Kaibab Ls			650	36.90748705	-112.4782522	No	USGS 2010b	
220	NWIS-2	362521113032601		B-35-07 20ADA		North Buffer	Uinkaret Plateau - South	Perched	Well				460	36.4224816	-113.0579858	No	USGS 2010b	
221	GWSI-1	362047112432901	1	B-34-04 16D		North Buffer	Grand Canyon - Central	Regional	Spring	Muav Ls				36.346371969	-112.725470752	Yes	ADWR 2009b	
221	NWIS-2	362047112432901	2	B-34-04 16D UNSURVEYED		North Buffer	Grand Canyon - Central	Regional	Spring	Muav Ls				36.34637186	-112.725471	No	USGS 2010b	
221	Peterson-77	CF-11	3	RM151.5	151.5	North Buffer	Grand Canyon - Central	Regional	Spring	Muav Ls				36.346371871	-112.725470953	Yes	Peterson et al. 1977	
222	SIR-2010-5025	362802112374601	1	Kanab Spring; B-35-03 05-2		North Buffer	Kanab Creek - Lower	Regional	Spring					36.465528	-112.628694	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
222	NWIS-1	362802112374601	2			North Buffer	Kanab Creek - Lower	Regional	Spring					36.46722222	-112.62944444	Yes	USGS 2009a	
223	SIR-2010-5025	362723112382801	1	Shower Bath Spring; B-35-03 05-1		North Buffer	Kanab Creek - Lower	Regional	Spring					36.456806	-112.642667	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
223	NWIS-1	362723112382801	2	Showerbath Spring		North Buffer	Kanab Creek - Lower	Regional	Spring					36.45638889	-112.64111111	Yes	USGS 2009a	
224	SIR-2010-5025	362702112394701	1	Side Canyon Spring; B-35-04 12		North Buffer	Kanab Creek - Lower	Regional	Spring					36.450361	-112.663972	Yes	Bills et al. 2010	North Segregation/East Kanab Basin Springs - West Kanab, Active Mine Area, on Standby (Kanab North, Arizona One, and Pinenut Mines), and Reclaimed (Hermit, Hack Canyon Mines)
224	NWIS-1	362702112394701	2			North Buffer	Kanab Creek - Lower	Regional	Spring					36.45055556	-112.66305556	Yes	USGS 2009a	
225	EFN-88b	SW-KC3		Kanab Creek Downstream from Snake Gulch		North Buffer	Kanab Creek - Central	N/A	Stream					36.63593	-112.62643	Yes	Energy Fuels Nuclear 1988b	
226	EFN-88b	SW-KC1		Kanab Creek Downstream from Hack Canyon		North Buffer	Kanab Creek - Lower	N/A	Stream					36.54911	-112.65096	Yes	Energy Fuels Nuclear 1988b	
227	NWIS-1	361947112550200		Cottonwood Creek North Rim Grand Canyon		North Buffer	Tuckup Canyon	N/A	Stream					36.32972222	-112.91722222	Yes	USGS 2009a	
228	NWIS-2	364650113084001		B-39-08 15CAB		North Buffer	Uinkaret Plateau - Central	N/D	Well					36.7805404	-113.14522	No	USGS 2010b	
229	NWIS-2	365050112521201		B-40-05 19DCC		North Buffer	Uinkaret Plateau - North	N/D	Well					36.8472075	-112.8707635	No	USGS 2010b	
230	NWIS-2	365045112521001		B-40-05 30ABB		North Buffer	Uinkaret Plateau - North	N/D	Well					36.8458186	-112.8702079	No	USGS 2010b	
231	NWIS-2	365205112582001		B-40-06 18ADD		North Buffer	Uinkaret Plateau - North	N/D	Well					36.8680405	-112.9729904	No	USGS 2010b	
232	NHD-1	126013714				East	Lees Ferry Vicinity	Mesozoic	Spring					36.8101706095	-111.65786127	No	USGS 2007	
233	NWIS-2	363822111515101		A-37-05 04ABC		East	Marble Platform	Mesozoic	Well	Holocene Alluvium			50	36.6394312	-111.8648899	Yes	USGS 2010b	
234	GCWC-02-Map	M-391		Rock Spring??; A-38-03 35CA		East	Kaibab Plateau	Perched	Spring					36.64848	-112.0467	No	Grand Canyon Wildlands Council 2002	
235	NWIS-2	364856111380701		A-39-07 03BAB		East	Lees Ferry Vicinity	N/D	Well				1205	36.81554315	-111.6359945	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
236	GWSI-1	365056111320101	1	01 029-01.85X10.42		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Navajo Ss				36.848877531	-111.534324602	Yes	ADWR 2009b	
236	NWIS-2	365056111320101	2	01 029-01.85X10.42		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Navajo Ss				36.8488774	-111.5343247	No	USGS 2010b	
237	GWSI-1	365150111343901	1	Lee's Ferry Spring; A-40-08 18DBC		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Chinle Fm				36.863876825	-111.57821557	Yes	ADWR 2009b	
237	NWIS-2	365150111343901	2	A-40-08 18DBC2		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Chinle Fm				36.8638767	-111.5782156	Yes	USGS 2010b	
238	Taylor-97	FROG-SP		Frog Marsh Spring (Below Dam)		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring					36.84580556	-111.55725	Yes	Taylor et al. 1997	
239	GCWC-02	GCNRA-1		Lees Ferry Spring; A-40-08 18DB		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	Wingate Ss	Ephemeral	Contact		36.86667	-111.55833	Yes	Grand Canyon Wildlands Council 2002	Northeastern Arizona Strip at Lees Ferry, Az
240	GWSI-1	364557111360301	1	Navajo Spring; 03 029-05.59X16.13		East Buffer	Marble Platfrom	Mesozoic	Spring	Shinarump Mbr	Perennial	Seepage of Filtration		36.765821549	-111.60154737	No	ADWR 2009b	
240	NWIS-2	364557111360301	2	03 029-05.59X16.13		East Buffer	Marble Platfrom	Mesozoic	Spring	Shinarump Mbr				36.76582188	-111.6015477	Yes	USGS 2010b	
241	GWSI-1	363930111384501	1	Bitterspring; 03 044-08.12X06.27		East Buffer	Marble Platfrom	Mesozoic	Spring	Moenkopi Fm	Perennial	Seepage of Filtration		36.658321067	-111.646547548	No	ADWR 2009b	
241	NWIS-2	363930111384501	2	03 044-08.12X06.27		East Buffer	Marble Platfrom	Mesozoic	Spring	Moenkopi Fm				36.6583214	-111.6465479	Yes	USGS 2010b	
242	Springs_0103	NAV		Navajo Spring		East Buffer	Marble Platfrom	Mesozoic	Spring					36.7730723215	-111.618888052	No	BLM 2010c	
243	NHD-1	126006126				East Buffer	Marble Platfrom	Mesozoic	Spring					36.7235666763	-111.625973804	No	USGS 2007	
244	NHD-1	126013047				East Buffer	Marble Platfrom	Mesozoic	Spring					36.7854294762	-111.599279071	No	USGS 2007	
245	GWSI-1	365707112020301	1	Coyote Springs; A-41-03 13CBC		East Buffer	Paria Plateau	Mesozoic	Spring	Alluvium	Perennial	Perched		36.95192973	-112.03490272	No	ADWR 2009b	
245	NWIS-2	365707112020301	2	A-41-03 13CBC		East Buffer	Paria Plateau	Mesozoic	Spring	Holocene Alluvium				36.95193018	-112.0349024	Yes	USGS 2010b	
245	NURE	GCAH501R	3			East Buffer	Paria Plateau	Mesozoic	Spring	KBBL Carbonate				36.951585733	-112.03443569	Yes	USGS 2009b	
246	BLM-Legacy	LEG-232		Cottonwood Spring; A-41-04 08CAA		East Buffer	Paria Plateau	Mesozoic	Spring					36.96809	-111.99236	Yes	BLM 2010d	
247	BLM-Legacy	LEG-227		Pahole Seep; A-41-03 25AAD		East Buffer	Paria Plateau	Mesozoic	Spring					36.92878	-112.03141	No	BLM 2010d	
248	BLM-Legacy	LEG-230		Top Rock Spring; A-41-04 07AB		East Buffer	Paria Plateau	Mesozoic	Spring					36.9729	-112.00945	No	BLM 2010d	Spring in Disrepair/No Flow Rate Could Be Established Due to Nature of Spring Development
249	BLM-Legacy	LEG-193		Wilson Canyon Seeps; A-40-07 05AA		East Buffer	Paria Plateau	Mesozoic	Spring					36.90042	-111.66096	Yes	BLM 2010d	No Tds Report/Less Than Oil Flow
250	Springs_0103	PAWHOLE		Paw Hole		East Buffer	Paria Plateau	Mesozoic	Spring					36.9242520285	-112.016954309	No	BLM 2010c	
251	GWSI-1	364757111421501	1	Badger Spring; A-39-06 12BAD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.79915384	-111.70488612	No	ADWR 2009b	
251	NWIS-2	364757111421501	2	A-39-06 12BAD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.7991535	-111.7048858	Yes	USGS 2010b	
252	BLM-Legacy	LEG-145	1	Soap Creek Spring East; A-39-06 17DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.77792	-111.76996	Yes	BLM 2010d	
252	GWSI-1	364645111461301	2	Soap Creek Spring; A-39-06 17DAB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	Navajo Ss				36.779153482	-111.770999384	No	ADWR 2009b	
252	NWIS-2	364645111461301	3	A-39-06 17DAB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	Navajo Ss				36.77915315	-111.7709992	Yes	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
253	BLM-Legacy	LEG-196	1	Lowrey Spring; A-40-07 30A		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.84013	-111.68136	Yes	BLM 2010d	Pipeline at Time of Spring Schedule Figures Pipeline Has Been Redone (12/85)/New Well (Horizontal) Pipe and Tanks (Private)
253	GWSI-1	365022111405201	2	Lowrey Spring; A-40-07 30ACA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring			Contact		36.839430781	-111.681829944	No	ADWR 2009b	
253	NWIS-2	365022111405201	3	A-40-07 30ACA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	Moenave Fm				36.8394312	-111.68183	Yes	USGS 2010b	
254	GCWC-02-Map	M-137	1	Unnamed (two Mile Spring); A-40-03 34DAA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.82347	-112.05596	No	Grand Canyon Wildlands Council 2002	
254	NURE	GCAH502R	2			East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	TRSS Ss				36.822887742	-112.055332887	Yes	USGS 2009b	
255	GCWC-02-Map	M-142	1	Jacob Cliff; A-38-05 06AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.72858	-111.89771	No	Grand Canyon Wildlands Council 2002	
255	NURE	MCBA501R	2			East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	TRSS Ss				36.727387297	-111.898225449	Yes	USGS 2009b	
256	GCWC-02-Map	M-193		Twin Springs (Upper); A-40-06 35DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.81766	-111.72035	No	Grand Canyon Wildlands Council 2002	
257	GCWC-02-Map	M-138		Unnamed??; A-39-03 03DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.80317	-112.0597	No	Grand Canyon Wildlands Council 2002	
258	BLM-Legacy	LEG-133		One Mile Spring; A-39-03 03DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.80661	-112.05492	Yes	BLM 2010d	
259	BLM-Legacy	LEG-134		Deer Spring; A-39-03 11BB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.79864	-112.05336	Yes	BLM 2010d	Average Discharge=0.0025 Gallons per Minute/Deer Springs on Map Should Be House Rock Spring at this Location/Deer Spring is Located:T39N,R3E,10,Nene--Next Canyon North/Local
260	GCWC-02-Map	M-419		Four Springs; A-39-03 11DBB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.79398	-112.04602	No	Grand Canyon Wildlands Council 2002	
261	GCWC-02-Map	M-420		Four Springs; A-39-03 11DB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.79163	-112.04526	No	Grand Canyon Wildlands Council 2002	
262	GCWC-02-Map	M-421		Four Springs; A-39-03 11DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.78907	-112.04469	No	Grand Canyon Wildlands Council 2002	
263	GCWC-02-Map	M-422		Four Springs; A-39-03 14AB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.78628	-112.04473	No	Grand Canyon Wildlands Council 2002	
264	GCWC-02-Map	M-423		House Rock Spring; A-39-03 13CCB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.7762	-112.03588	No	Grand Canyon Wildlands Council 2002	
265	BLM-Legacy	LEG-141		Hancock Spring; A-39-05 31BA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.74193	-111.90403	Yes	BLM 2010d	a.K.a. Cottonwood/Improved Spring with 7500' of 1 1/4 Pipe to Trough and Reservoir on Patented Land/2+ Gals/Minute// Pipeline from Hancock Spring Down to Reservoir and Trough
266	BLM-Legacy	LEG-101		Sunset Spring; A-38-05 05CA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.71891	-111.88498	No	BLM 2010d	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
267	BLM-Legacy	LEG-100		Emmett Spring; A-38-05 08A		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.71102	-111.87558	Yes	BLM 2010d	T37N,R5E,4,Nwne=Dor1 Year Round/T38N,R5E,36,Swse=Lst2 169 0301-0228/ T38N,R6E,30,Swsw=Lst2 169 0301-0228/ T38N,R6E,17,Nene=Lst2 169 0301-0228/Jdr# Original Pipeline:4771 Ext 4
268	BLM-Legacy	LEG-96		Jacob Cliff Spring East; A-38-05 06AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.72747	-111.89573	Yes	BLM 2010d	
269	BLM-Legacy	LEG-97		Jacob Cliff Spring Main; A-38-05 06BA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.72842	-111.90332	Yes	BLM 2010d	Jdrs:1819 and 5006 Contain Pipeline Information for Jacobs Pools/Wet Area 6'×10'×325'
270	BLM-Legacy	LEG-98		Jacob Cliff Spring North; A-38-05 06BA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.72784	-111.90154	Yes	BLM 2010d	Wet Area: 8'×60'
271	BLM-Legacy	LEG-155		Cottonwood Seeps; A-39-06 21CB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.7632	-111.7634	Yes	BLM 2010d	
272	BLM-Legacy	LEG-153		Netherland Seep; A-39-06 10DAA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.79262	-111.7314	No	BLM 2010d	
273	BLM-Legacy	LEG-144	1	Dutchman Spring; A-39-06 10DBD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.79225	-111.73646	Yes	BLM 2010d	
273	BLM-Legacy	LEG-150	2	Dutchman Seep; A-39-06 10DBD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.79225	-111.73646	Yes	BLM 2010d	Seep Flow 0.25 Gallons per Minute/100% Wildlife Use
274	BLM-Legacy	LEG-146		Short Seep; A-39-06 27BAA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75746	-111.7404	No	BLM 2010d	
275	BLM-Legacy	LEG-149		Halfmoon Seep; A-39-06 29CDB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75111	-111.77963	Yes	BLM 2010d	
276	BLM-Legacy	LEG-154		Walts Spring; A-39-06 30DBC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.74829	-111.79217	Yes	BLM 2010d	Deer Use/Flow Estimated at 0.75 Gallons per Minute on 07-05-88
277	GCWC-02-Map	M-84		Twin Springs (Middle); A-40-06 35DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.81677	-111.71878	No	Grand Canyon Wildlands Council 2002	
278	GCWC-02-Map	M-435		Twin Springs (Lower); A-39-06 02A		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.81485	-111.71786	No	Grand Canyon Wildlands Council 2002	
279	GCWC-02-Map	M-429		Badger Spring; A-39-06 01B		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.81506	-111.70883	No	Grand Canyon Wildlands Council 2002	
280	BLM-Legacy	LEG-61		Seven Mile Spring Upper; A-40-06 36ADD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.82431	-111.69641	Yes	BLM 2010d	
281	BLM-Legacy	LEG-190		Seven Mile Seep; A-40-06 36DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.82294	-111.69622	No	BLM 2010d	
282	BLM-Legacy	LEG-192		Seven Mile Spring Lower; A-40-06 36DD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.81825	-111.69554	Yes	BLM 2010d	
283	BLM-Legacy	LEG-197		Seven Mile Seep; A-40-07 31CC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.81811	-111.69122	No	BLM 2010d	
284	BLM-Legacy	LEG-148		Smokey Spring; A-39-06 19DA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.76438	-111.78562	Yes	BLM 2010d	Flow Was 1.0 Gallons per Minute on 07-04-88
285	BLM-Legacy	LEG-147		Soap Spring; A-39-06 17AD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.7769	-111.76972	Yes	BLM 2010d	T39N,R6E,26,Nwse=Location of Trough
286	BLM-Legacy	LEG-102		Soap Creek Seep; A-38-05 02DB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.71995	-111.82555	No	BLM 2010d	Seep Exists High in Cliff/No Access to Source/No Flow Rate Or Tds/Ec Report
287	BLM-Legacy	LEG-132		908 Spring; A-39-03 25AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75541	-112.02146	Yes	BLM 2010d	Spring is Dry/Subject to Flash Flood

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
288	BLM-Legacy	LEG-139		Banal Spring; A-39-04 27AB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75775	-111.95535	Yes	BLM 2010d	Reported Section Was 22,Should Be 27 Listed in Amp File(House Rock)/No Jdr File Listed But Possible File #'S per Case File/ Schoppman,Melvin,Orjohn Are As Follows:1678,1402,7
289	BLM-Legacy	LEG-160		Combination Seeps; A-39-06 20C		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.76231	-111.78256	Yes	BLM 2010d	
290	BLM-Legacy	LEG-161		Cottonwood Spring Upper; A-39-06 21CB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.76314	-111.76501	Yes	BLM 2010d	
291	BLM-Legacy	LEG-162		Cottonwood Spring Lower; A-39-06 21CB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.76177	-111.76333	Yes	BLM 2010d	Location of Cottonwood Spring(Seep)Located on Emmett Wash 15'is in Wrong Location,Instead of T39N,R6E,32,Swnw,Should Read T39N,R6E,29,Swnw on Paria Plateau Se 7.5' Map/No Li
292	BLM-Legacy	LEG-164		Early Seep; A-39-06 01CC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.80379	-111.71043	Yes	BLM 2010d	
293	BLM-Legacy	LEG-156		Eyewhere Seep; A-39-06 29DB		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.74991	-111.77813	Yes	BLM 2010d	
294	BLM-Legacy	LEG-194	1	Fisher Springs Upper; A-40-07 16ADC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.86856	-111.6454	Yes	BLM 2010d	Single Pipeline from Fisher Down Canyon to Natural Rock Pool in Same Section
294	BLM-Legacy	LEG-195	2	Fisher Springs Lower; A-40-07 16AD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.86856	-111.6454	Yes	BLM 2010d	Two Springs Located at Fisher Spring/Upper Spring with Pipeline
295	BLM-Legacy	LEG-135		Hod Brown Seep West; A-39-03 13BC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.78122	-112.03468	Yes	BLM 2010d	
296	BLM-Legacy	LEG-136		Hod Brown Seep East; A-39-03 13BC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.78122	-112.03468	Yes	BLM 2010d	
297	BLM-Legacy	LEG-137		Hod Brown Spring; A-39-03 13BC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.78122	-112.03468	Yes	BLM 2010d	12' Tunnel with Collection Box(Which is Trash Can Lid)/Poor Condition,Pipe Broken/Pipeline Shown on Folks'S Wilderness Map/Local Name:Hod Brown
298	BLM-Legacy	LEG-158		Ima Spring; A-39-06 20DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75959	-111.773	Yes	BLM 2010d	
299	BLM-Legacy	LEG-159		Ima Seep; A-39-06 20DC		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75959	-111.773	Yes	BLM 2010d	
300	BLM-Legacy	LEG-157		Laurita Spring; A-39-06 19DD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.76062	-111.78666	Yes	BLM 2010d	
301	BLM-Legacy	LEG-143		Lightening Spring; A-39-06 20AA		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.77185	-111.76825	Yes	BLM 2010d	
302	BLM-Legacy	LEG-163		Old Juniper Spring; A-39-06 20CD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.76125	-111.77727	Yes	BLM 2010d	
303	BLM-Legacy	LEG-152		Lower Badger Spring; A-39-06 01D		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.80668	-111.69898	Yes	BLM 2010d	Domestic Use at Vermilion Cliff Lodge/Three Culinary Tanks:One Steel and Two Were Rock Tanks/ Average Discharge Spring>5.0 Gallons per Minute
304	BLM-Legacy	LEG-140		Parker Spring; A-39-04 30BD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75302	-112.01142	Yes	BLM 2010d	No Flow Could Be Measured/ Parker Spring is a Deep Cistern 9'Deep,2'Wide
305	BLM-Legacy	LEG-189		Unknown Private Spring; A-40-03 34DD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.81862	-112.0572	Yes	BLM 2010d	
306	BLM-Legacy	LEG-151		A-39-06 29B (seep)		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.75517	-111.78076	Yes	BLM 2010d	No Flow at Spring Source/Damp Soil Only 08-08-85/Spring Re-Emerges Below

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
307	NHD-1	126015281				East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring					36.7626388763	-111.966644803	No	USGS 2007	
308	NWIS-2	365208111354301		A-40-07 13ACB		East Buffer	Lees Ferry Vicinity	Mesozoic	Well				200	36.86887645	-111.595994	No	USGS 2010b	
309	NWIS-2	365204111353801		A-40-07 13ACC		East Buffer	Lees Ferry Vicinity	Mesozoic	Well	Moenave Fm			80	36.86776537	-111.5946051	Yes	USGS 2010b	
310	NWIS-2	365200111345001		A-40-08 18CAB		East Buffer	Lees Ferry Vicinity	Mesozoic	Well	Moenkopi Fm			200	36.8666544	-111.5812713	No	USGS 2010b	
311	NWIS-2	365158111345401		A-40-08 18CBA		East Buffer	Lees Ferry Vicinity	Mesozoic	Well	Holocene Alluvium			34	36.86609887	-111.5823824	Yes	USGS 2010b	
312	NWIS-2	365150111344001		A-40-08 18DBC1		East Buffer	Lees Ferry Vicinity	Mesozoic	Well	Chinle Fm			203	36.8638767	-111.5784934	No	USGS 2010b	
313	NWIS-2	364829112010001		A-39-04 06CBB		East Buffer	Paria Plateau	Mesozoic	Well	Moenave Fm			700	36.80804305	-112.017398	Yes	USGS 2010b	
314	NWIS-2	365335111591001		A-40-04 05DAC1		East Buffer	Paria Plateau	Mesozoic	Well	Moenave Fm			300	36.89304177	-111.9868434	No	USGS 2010b	
315	NWIS-2	365334111591001		A-40-04 05DAC2		East Buffer	Paria Plateau	Mesozoic	Well	Moenave Fm			700	36.89276399	-111.9868434	No	USGS 2010b	
316	NWIS-2	365131112004501		A-40-04 19BAB		East Buffer	Paria Plateau	Mesozoic	Well	Moenave Fm			610	36.8585979	-112.0132325	No	USGS 2010b	
317	NWIS-2	365035111574401		A-40-04 27BBC		East Buffer	Paria Plateau	Mesozoic	Well	Moenave Fm			920	36.84304227	-111.9629524	No	USGS 2010b	
318	NWIS-2	365540111574801		A-41-04 28ADA		East Buffer	Paria Plateau	Mesozoic	Well	Moenave Fm			920	36.9277635	-111.9640654	Yes	USGS 2010b	
319	NURE	MCAA501R				East Buffer	Paria Plateau	Mesozoic	Well	TRSS Ss				36.925785783	-111.970732329	Yes	USGS 2009b	
320	NWIS-2	364818112033201		A-39-03 03DBD		East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Well	Moenave Fm			125	36.80498806	-112.0596214	Yes	USGS 2010b	
321	GCWC-02-Map	M-366	1	Kane Spring; A-37-03 23CD		East Buffer	Kaibab Plateau	Perched	Spring					36.58589	-112.04517	No	Grand Canyon Wildlands Council 2002	
321	NURE	GCBH501R	2			East Buffer	Kaibab Plateau	Perched	Spring	UNKN Ss				36.585686378	-112.04532917	Yes	USGS 2009b	
322	GCWC-02-Map	M-171		Tater Canyon Spring; A-36-03 27BB		East Buffer	Kaibab Plateau	Perched	Spring					36.49573	-112.07151	No	Grand Canyon Wildlands Council 2002	
323	GCWC-02-Map	M-418		Burro Spring; A-40-03 32DD		East Buffer	Kaibab Plateau	Perched	Spring					36.81823	-112.09448	No	Grand Canyon Wildlands Council 2002	
324	GCWC-02-Map	M-434		Aho; A-39-06 30		East Buffer	Kaibab Plateau	Perched	Spring					36.75249	-112.12127	No	Grand Canyon Wildlands Council 2002	
325	NPS_All_Hydro	TW-1				East Buffer	Marble Canyon	Perched	Spring					36.6993301931	-111.71162556	No	Grand Canyon National Park 2010b	
326	SIR-2010-5025	363907111471701	1	Rider Spring; A-38-06 31		East Buffer	Marble Platform	Perched	Spring					36.651944	-111.788056	Yes	Bills et al. 2010	East Segregation/House Rock Springs - House Rock Area, No Uranium Mines, Breccia Pipes Present
326	NWIS-1	363907111471701	2	Rider Spring		East Buffer	Marble Platform	Perched	Spring					36.65194444	-111.78805556	Yes	USGS 2009a	
326	GCWC-02-Map	M-399	3	Rider Spring; A-38-06 31AA		East Buffer	Marble Platform	Perched	Spring					36.65293	-111.78748	No	Grand Canyon Wildlands Council 2002	
327	SIR-2010-5025	362856111542301		South Canyon Spring; A-36-05 31		East Buffer	Marble Platform	Perched	Spring					36.482222	-111.906389	Yes	Bills et al. 2010	East Segregation/House Rock Springs - House Rock Area, No Uranium Mines, Breccia Pipes Present

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
328	GCWC-02-Map	M-338		A-36-04 36 (seep)		East Buffer	Marble Platform	Perched	Spring					36.47598	-111.92185	No	Grand Canyon Wildlands Council 2002	No Spring on Topo
329	NWIS-2	364932111375101		A-40-07 34ACC		East Buffer	Lees Ferry Vicinity	Perched	Well	Coconino Ss			540	36.8255431	-111.63155	No	USGS 2010b	
330	NWIS-2	363759111392901		03 044-08.76X08.07		East Buffer	Marble Platfrom	Perched	Well	Coconino Ss			428	36.63304347	-111.6587702	No	USGS 2010b	
331	GWSI-1	362957111512601	1	Vasey's Paradise Spring; A-36-05 27B		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls	Perennial	Tubular Cave		36.499153222	-111.857943296	Yes	ADWR 2009b	
331	NWIS-2	362957111512600	2	N14 Vasey's Paradise, R iver Mile 31.9	31.9	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.49915289	-111.8579435	Yes	USGS 2010b	
331	GCNP-1	COLO029	3	Vasey's Paradise at pool		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.497726632	-111.857826815	Yes	Grand Canyon National Park 2010a	
331	SIR-2010-5025	362957111512601	4	Vasey's Paradise Spring; A-36-05 27B UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.499167	-111.857222	Yes	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of The Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
331	NWIS-2	362957111512601	5	A-36-05 27B UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.49915289	-111.8579435	Yes	USGS 2010b	
331	ONWI-85	Spr10	6	River Mile 31.8; West bank; Vasey's Paradise Spring	31.8W	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.499167	-111.857222	Yes	Woodward-Clyde Consultants 1985	
331	Peterson-77	CF-1	7	Vasey's Paradise, RM 31.9	31.9	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.499152922	-111.857943496	Yes	Peterson et al. 1977	
331	GCWC-02	GCNP-102	8	Vaseys Paradise; A-36-05 27B		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls	Perennial	Contact; Fracture		36.5017	-111.85945	Yes	Grand Canyon Wildlands Council 2002	Colorado River in Grand Canyon Mile 31.9, at Rivers Edge North Side
332	GWSI-1	362837111504201	1	Hanging Spring; A-36-05 34A		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.476930209	-111.845720434	Yes	ADWR 2009b	
332	NWIS-2	362837111504201	2	Redwall Spring at RM34.2; A-36-05 34A UNSURVEYED	34.2	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.47693065	-111.8457204	Yes	USGS 2010b	
332	SIR-2010-5025	362837111504201	3	Hanging Spring; A-36-05 34A UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring					36.476944	-111.845	Yes	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of The Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
332	Peterson-77	CF-3	4	River Mile 34.2	34.2	East Buffer	Marble Canyon	Regional	Spring	Redwall Ls				36.476930609	-111.845720434	Yes	Peterson et al. 1977	
333	SIR-2010-5025	363123111503101	1	A-36-05 14; Fence Spring		East Buffer	Marble Canyon	Regional	Spring					36.523056	-111.841944	Yes	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of The Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
333	NWIS-1	363123111503101	2	Fence Spring		East Buffer	Marble Canyon	Regional	Spring					36.52305556	-111.84194444	Yes	USGS 2009a	
334	SIR-2010-5025	362831111504401	1	Hole in the Wall Spring; A-36-05 34DBA UNSURVEYED		East Buffer	Marble Canyon	Regional	Spring					36.475278	-111.845556	Yes	Bills et al. 2010	
334	NWIS-1	362831111504401	2	Hole-in-the-Wall Spring		East Buffer	Marble Canyon	Regional	Spring					36.47526398	-111.84627599	Yes	USGS 2009a	
335	GCWC-02-Map	M-38	1	Hanging Springs; A-36-05 34		East Buffer	Marble Canyon	Regional	Spring					36.47378	-111.84561	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
335	SIR-2010-5025	362827111504101	2	Unknown Spring; A-36-05 34		East Buffer	Marble Canyon	Regional	Spring					36.474167	-111.844722	Yes	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of The Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
335	NWIS-1	362827111504101	3			East Buffer	Marble Canyon	Regional	Spring					36.47416667	-111.84472222	Yes	USGS 2009a	
336	ONWI-85	Spr01		River Mile 25.3; East bank	25.3 E	East Buffer	Marble Canyon	Regional	Spring					36.5756989548	-111.794093644	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con
337	GCNP-1	COLO027	1	Fence Fault River Left		East Buffer	Marble Canyon	Regional	Spring					36.51885	-111.8458917	Yes	Grand Canyon National Park 2010a	
337	ONWI-85	Spr02	2	River Mile 30.5; East bank	30.5 E	East Buffer	Marble Canyon	Regional	Spring					36.5193755158	-111.845560267	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con
338	ONWI-85	Spr03		River Mile 30.6: East bank	30.6 E	East Buffer	Marble Canyon	Regional	Spring					36.5179057511	-111.845830322	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con
339	GCNP-1	COLO026	1	Fence Fault River Right		East Buffer	Marble Canyon	Regional	Spring					36.5155167	-111.8479639	Yes	Grand Canyon National Park 2010a	
339	ONWI-85	Spr04	2	River Mile 30.8; West bank	30.8W	East Buffer	Marble Canyon	Regional	Spring					36.5153410469	-111.847892133	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con
340	ONWI-85	Spr05		River Mile 30.7; West bank	30.7W	East Buffer	Marble Canyon	Regional	Spring					36.5168034074	-111.847410344	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
341	ONWI-85	Spr06		River Mile 30.7; East bank; Marble Platform end member	30.7E	East Buffer	Marble Canyon	Regional	Spring					36.5164682212	-111.846115093	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con
342	ONWI-85	Spr07		River Mile 35.0; West bank	35.0W	East Buffer	Marble Canyon	Regional	Spring					36.4701527469	-111.841452938	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con
343	ONWI-85	Spr09		River Mile 31.2; West bank; Kaibab Plateau end member	31.2W	East Buffer	Marble Canyon	Regional	Spring					36.5102826648	-111.850994644	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on/Near Fault Zones, Fractures, Or Joints Along The Colorado River; Samples Considered Representative of in Situ Con
344	GCNP-1	COLO045		Monkey Flower Spring	34R	East Buffer	Marble Canyon	Regional	Spring					36.4727778	-111.843611	No	Grand Canyon National Park 2010a	
345	GCWC-02	GCNP-101		Fence Fault north; A-36-05 15A		East Buffer	Marble Canyon	Regional	Spring	Redwall Ls	Perennial	Contact; Fracture		36.52575	-111.84546	Yes	Grand Canyon Wildlands Council 2002	Colorado River in Grand Canyon Mile 30.3, at Rivers Edge Right North (Side)
346	NHD-1	126014479				East Buffer	Marble Canyon	Regional	Spring					36.52921581	-111.833306404	No	USGS 2007	
347	NWIS-2	363114111504200		South Canyon Springs at River Mile 31.5	31.5	East Buffer	Marble Canyon	N/A	Stream					36.5205419	-111.845721	No	USGS 2010b	
348	NWIS-2	362737111463701		03 062-01.46X02.72		East Buffer	Marble Platform	N/D	Well				1000	36.4602644	-111.7776616	No	USGS 2010b	
349	NWIS-2	363932111383901		03 044-07.96X06.25		East Buffer	Marble Platfrom	N/D	Well				100	36.65887698	-111.6448812	Yes	USGS 2010b	
350	NWIS-2	355820112072001		A-30-02 24ACC2		South	Coconino Plateau - East	Mesozoic	Well	Shinarump Mbr				35.97109547	-112.1279459	No	USGS 2010b	
352	USFS-10	Miller_Seep		Miller Seep; A-29-03 21		South	Coconino Plateau - East	Perched	Spring					35.8867770776	-112.06806107	No	U.S. Forest Service 2010	Location from USGS 2010c
353	NWIS-2	355820112072101		A-30-02 24ACC1		South	Coconino Plateau - East	Perched	Well				650	35.971651	-112.127668	No	USGS 2010b	
354	NWIS-2	355710112074001		A-30-02 25C		South	Coconino Plateau - East	Perched	Well				623	35.95276278	-112.1285012	Yes	USGS 2010b	
355	NWIS-2	355610111464001		A-30-06 32CC		South	Coconino Plateau - East	Perched	Well				1330	35.93610107	-111.778488	No	USGS 2010b	
356	NWIS-2	355308112054101	1	Canyon Mine Well; A-29-03 20BDB		South	Coconino Plateau - East	Regional	Well	Muav Ls			3086	35.88554296	-112.0954438	Yes	USGS 2010b	
356	SIR-2010-5025	355308112054101	2	Canyon Mine Well; A-29-03 20BDB		South	Coconino Plateau - East	Regional	Well	Muav Ls			3086	35.883583	-112.09675	Yes	Bills et al. 2010	South Segregation Groundwater Well - Active Mine, on Standby
356	M&A-93a	CMW	3	Canyon Mine Well; A-29-03 20BDB		South	Coconino Plateau - East	Regional	Well	Redwall-Muav Aquifer				35.88553	-112.09544	Yes	M&A 1993a	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
356	STORET-1	GRCA_GS2_ CMWL02	4	Canyon Mine Well		South	Coconino Plateau - East	Regional	Well	Muav Aquifer				35.8855736	-112.0954708	Yes	USEPA 2010	Canyon Mine Well is Completed to a Depth of 3086 Feet in The Muav Limestone (374Muav) Local Aquifer. The Well is Located Outside The Boundary of Grand Canyon National Park, in Kaibab National Forest, Near Little Red Horse Wash. The Usgs Site Id is 3553081
357	NWIS-2	355815112072601		A-30-02 24ACD		South	Coconino Plateau - East	Regional	Well	Redwall Ls			3120	35.9708177	-112.1246124	No	USGS 2010b	
358	NWIS-2	355826112074401		A-30-02 24BAD		South	Coconino Plateau - East	Regional	Well	Muav Ls			3000	35.97395648	-112.1294737	No	USGS 2010b	
359	NWIS-2	355811112074501		A-30-02 24CAB		South	Coconino Plateau - East	Regional	Well	Redwall Ls			3108	35.97023439	-112.1309182	Yes	USGS 2010b	
360	NWIS-2	355955112115401		A-30-02 08A1		South	Coconino Plateau - East	N/D	Well					35.9985944	-112.1990595	No	USGS 2010b	
361	NWIS-2	355954112115401		A-30-02 08A2		South	Coconino Plateau - East	N/D	Well					35.99831665	-112.1990595	No	USGS 2010b	
362	NWIS-2	355830112081001		A-30-02 24BBB		South	Coconino Plateau - East	N/D	Well					35.9749842	-112.136835	No	USGS 2010b	
363	NWIS-2	355720112074001		A-30-02 25B		South	Coconino Plateau - East	N/D	Well					35.95554046	-112.1285012	No	USGS 2010b	
364	NHD-1	124578793				South Buffer	Coconino Plateau - East	Perched	Spring					35.7226250112	-111.82869527	No	USGS 2007	
365	NWIS-2	360952112203501		A-32-01 13 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Perched	Spring					36.16442575	-112.3437879	No	USGS 2010b	
366	NWIS-2	360711112184601		A-32-01 32 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Perched	Spring					36.11970404	-112.3135086	No	USGS 2010b	
367	STORET-1	GRCA_FIT_ EREM02	1	Dripping Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Hermit Sh - Coconino Ss				36.063333	-112.243167	No	USEPA 2010	Dripping Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Upper Reaches of The Hermit Creek Drainage. Dripping Springs Flows from The Outcrop at The Hermit Shale-Coconino Sandstone, The Spring Orifice Faces South
367	GCNP-1	EREM002	2	Dripping Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Coconino/ Hermit Contact				36.062679383	-112.24263762	Yes	Grand Canyon National Park 2010a	
367	Fitz-96	DRIP	3	Dripping Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Hermit Sh - Coconino Ss	Perennial	Contact		36.06633	-112.24633	Yes	Fitzgerald 1996	
368	STORET-1	GRCA_FIT_ HERM08	1	Santa Maria Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Esplanade Ss				36.06	-112.221944	No	USEPA 2010	Santa Maria Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Upper Reaches of The Hermit Creek Drainage. Santa Maria Spring Issues from Sandstone Beds in The Esplanade Formation, There Are No Associated Structure
368	GCNP-1	HERM008	2	Santa Maria Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Supai Fm				36.0600715	-112.221833981	Yes	Grand Canyon National Park 2010a	
368	Fitz-96	SANMA	3	Santa Maria Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Esplanade Ss	Perennial	Bedding Planes		36.0595	-112.219833	Yes	Fitzgerald 1996	
369	STORET-1	GRCA_FIT_ KOLB02	1	Kolb Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring					36.0577778	-112.1427778	No	USEPA 2010	Kolb Spring is Located on The South Rim Within The Boundary of Grand Canyon National Park Near Grand Canyon Village at The Start of The Bright Angel Trail.
369	Fitz-96	KOLB	2	Kolb Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring	Coconino Ss	Intermittent			36.0577778	-112.1427778	Yes	Fitzgerald 1996	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
370	NHD-1	GNIS-00011060		Seep Spring		South Buffer	Grand Canyon - South Rim	Perched	Spring					36.1817504772	-112.400786603	No	USGS 2007	
371	NPS_All_Hydro	HP-22e				South Buffer	Grand Canyon - South Rim	Perched	Spring					36.1374712589	-112.317514206	No	Grand Canyon National Park 2010b	
372	NPS_All_Hydro	HP-24b				South Buffer	Grand Canyon - South Rim	Perched	Spring					36.1076409205	-112.316095119	No	Grand Canyon National Park 2010b	
373	NPS_All_Hydro	HP-25c				South Buffer	Grand Canyon - South Rim	Perched	Spring					36.1282070205	-112.280171629	No	Grand Canyon National Park 2010b	
374	NPS_All_Hydro	HP-65c				South Buffer	Grand Canyon - South Rim	Perched	Spring					36.1611757721	-112.458300348	No	Grand Canyon National Park 2010b	
375	NPS_All_Hydro	VT-16				South Buffer	Grand Canyon - South Rim	Perched	Spring					36.0546277371	-111.819209678	No	Grand Canyon National Park 2010b	
376	NWIS-2	354202111365401		03 118-06.45X03.45		South Buffer	Coconino Plateau - East	Perched	Well				133	35.70055514	-111.6157062	No	USGS 2010b	
377	NWIS-2	354233111371001		03 118-06.70X02.85		South Buffer	Coconino Plateau - East	Perched	Well				300	35.709166	-111.6201505	No	USGS 2010b	
378	NWIS-2	354347112070901		A-27-02 13AAA		South Buffer	Coconino Plateau - East	Perched	Well				1100	35.72971515	-112.1198873	No	USGS 2010b	
379	NWIS-2	355221112182701		A-29-01 29BAD		South Buffer	Coconino Plateau - East	Perched	Well	Coconino Ss			1275	35.8724874	-112.3082282	No	USGS 2010b	
380	NWIS-2	355148112181601		A-29-01 29DCB		South Buffer	Coconino Plateau - East	Perched	Well	Coconino Ss			1130	35.86332105	-112.3051725	No	USGS 2010b	
381	NWIS-2	360205112104601	1	Rowe Well; A-31-02 33ABB		South Buffer	Coconino Plateau - East	Perched	Well					36.03470517	-112.1801704	No	USGS 2010b	
381	GCNP-1	ROWE001	2	Rowe Well		South Buffer	Coconino Plateau - East	Perched	Well	Kaibab LS				36.0347671	-112.1799968	Yes	Grand Canyon National Park 2010a	
382	NWIS-2	355430112202001		B-29-01 12DBD		South Buffer	Coconino Plateau - East	Perched	Well	Coconino Ss			1080	35.90831956	-112.3396186	Yes	USGS 2010b	
383	NWIS-2	355750112231001		B-30-01 28AAA1		South Buffer	Coconino Plateau - East	Perched	Well	Coconino Ss				35.9638735	-112.3868429	No	USGS 2010b	
384	NWIS-2	355750112231002		B-30-01 28AAA2		South Buffer	Coconino Plateau - East	Perched	Well	Coconino Ss			1020	35.9638735	-112.3868429	Yes	USGS 2010b	
385	NWIS-2	355740112234001		B-30-01 28BAA		South Buffer	Coconino Plateau - East	Perched	Well	Coconino Ss			1051	35.9610958	-112.3951765	No	USGS 2010b	
445	NWIS-2	354206111555601		A-27-04 23DCC		South Buffer	Coconino Plateau - East	Perched	Well				2250	35.70166238	-111.9329374	No	USGS 2010b	
386	NURE	GCDG501R				South Buffer	Coconino Plateau - East	Perched	Well	QTRN				36.012683176	-112.298929421	Yes	USGS 2009b	
387	STORET-1	GRCA_GS2_ GRAP07	1	Grapevine Main Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0110909	-112.0033028	No	USEPA 2010	Grapevine Main Spring is in a Small Canyon That is Tributary to The Main Southeast Trending Canyon of Grapevine Creek About 3 Km Upstream from The Tonto Trail. Water Discharges from Bedding Planes at Several Places in The Upper Part of The Muav Limestone
387	Monroe-05	360232112004802	2	Grapevine Main Spring; upper Bright Angel near Muav contact (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.0092664923	-112.002557176	Yes	Monroe et al. 2005	
387	NWIS-2	360040112000901	3	A-30-04 01 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.011111	-112.0025	Yes	USGS 2010b	Coordinates Based on Site Id

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
388	NWIS-2	360059111581700	1	VT9 Miners Spring at Trail in Hance Canyon		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.01637288	-111.972108	Yes	USGS 2010b	
388	STORET-1	GRCA_FIT_ PAGE02	2	Page Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls - Bright Angel Sh		Contact		36.016167	-111.973	No	USEPA 2010	Page Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Upper Reaches of The Hance Creek Drainage. The Spring Discharges from The Muav Limestone-Bright Angel Shale Contact and Flow Was Constant Throughout The Durat
388	Fitz-96	PAGE	3	Page Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent	Contact; Fold axis		36.0161667	-111.973	Yes	Fitzgerald 1996	
388	NWIS-2	360100111582001	4	A-30-04 04 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall Ls				36.01665064	-111.9729413	Yes	USGS 2010b	
388	Monroe-05	360100111582001	5	Miners Spring; upper Bright Angel near Muav contact (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls				36.0146513792	-111.971428242	Yes	Monroe et al. 2005	
389	STORET-1	GRCA_GS2_ HANC03	1	Hance Creek Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0000694	-111.9525	No	USEPA 2010	The Spring Emerges from a Wall in a Southwest Facing Alcove, in East Arm at The Source of Hance Creek. Samples Were Collected Five Meters Down The Drainage from The Wall. Discharge Was Determined at a Bright Angel Formation Ledge Near The Spring. The Sit
389	Monroe-05	360025111571501	2	JT Spring (Hance Spring; upper Bright Angel nr Muav contact (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls				36.0024888923	-111.951010589	Yes	Monroe et al. 2005	
389	NWIS-2	360025111571501	3	A-30-04 10 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.00692874	-111.9548848	Yes	USGS 2010b	
390	NWIS-2	360020111560401	1	Red Canyon Spring; A-30-04 11 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.00554019	-111.9351617	Yes	USGS 2010b	
390	Monroe-05	360020111560401	2	Red Canyon Spring; upper Bright Angel near Muav contact (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls				36.003934951	-111.934451814	Yes	Monroe et al. 2005	
391	STORET-1	GRCA_GS2_ BOUC07	1	Boucher Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0897709	-112.2603246	No	USEPA 2010	Boucher Spring is Located in The Main Drainage of Boucher Creek. The Spring Discharges from The Contact Between The Redwall Limestone and Muav Limestone. Additional Seeps Exist Below The Spring on Both Sides of The Channel. The Site is Located Within The
391	NWIS-2	360511112155501	2	A-31-01 10 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.086371	-112.2660067	Yes	USGS 2010b	
392	STORET-1	GRCA_FIT_ GARD05	1	Two Trees Spring (Pumphouse Spring)		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0775307	-112.1261403	No	USEPA 2010	Two Trees Spring (Also Known As Pumphouse Spring and Indian Garden Spa) is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Garden Creek Drainage. Samples Were Collected from Below Two Trees on Eastern Canyon Wall. The Dis
392	GCNP-1	GARD005	2	Two Tree Spring at Spring Box		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0775307	-112.1261403	Yes	Grand Canyon National Park 2010a	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
392	NWIS-2	360441112073201	3	A-31-02 13 UNSURV		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.07803835	-112.1262803	Yes	USGS 2010b	
392	Monroe-05	360441112073201	4	Pumphouse Spring; mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Alluvium				36.0757061384	-112.125390342	Yes	Monroe et al. 2005	
392	Fitz-96	TWOTREE	5	Two Tree Springs in Indian Garden basin		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault		36.0781667	-112.125667	Yes	Fitzgerald 1996	
393	GCNP-1	SALT004	1	Salt creek at Source		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav LS				36.0768635	-112.161769	Yes	Grand Canyon National Park 2010a	
393	Monroe-05	360439112094101	2	Salt Creek Spring; upper Bright Angel (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.0750407332	-112.161016483	Yes	Monroe et al. 2005	
393	NWIS-2	360439112094101	3	A-31-02 15 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.0774826	-112.1621147	Yes	USGS 2010b	
394	NWIS-2	360347112133001		A-31-02 18 2 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0713713	-112.2193385	Yes	USGS 2010b	
395	NWIS-2	360400112025001	1	A-31-03 14 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.06664989	-112.0479446	Yes	USGS 2010b	
395	Monroe-05	360400112025001	2	Lonetree Spring; upper Bright Angel near Muav contact (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.0647634503	-112.047253581	Yes	Monroe et al. 2005	
396	STORET-1	GRCA_FIT_ GRAP03	1	Grapevine East Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.0422846	-112.012395	No	USEPA 2010	Grapevine East Springs Are Located in The South Rim Within The Boundary of Grand Canyon National Park in The Grapevine Creek Drainage, at The Tonto Trail. Discharge from The Bright Angel Shale is Constant and Heavy Vegetation Growth Occurs Around The Spri
396	Fitz-96	GRAP-E	2	Grapevine East Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh	Intermittent	Fold axis		36.042833	-112.0135	Yes	Fitzgerald 1996	
396	Monroe-05	360232112004801	3	Grapevine East Spring; lower Bright Angel (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.0404607299	-112.011647689	Yes	Monroe et al. 2005	
396	NWIS-2	360232112004801	4	Grapevine East Spring; A-31-03 25 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.04220565	-112.0140544	Yes	USGS 2010b	
396	GCNP-1	GRAP003	5	Grapevine East spring at Tonto Trail		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.042513652	-112.013652492	Yes	Grand Canyon National Park 2010a	
397	NWIS-2	360108111592600		A-31-04 32		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.02442815	-111.9882199	Yes	USGS 2010b	
398	NWIS-2	360128111591200		A-31-04 32 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.02444	-111.98667	Yes	USGS 2010b	Coordinates Assigned from Site Id
399	NWIS-2	361141112211101		A-32-01 02 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.19470315	-112.3537885	Yes	USGS 2010b	
400	NWIS-2	360814112195100		A-32-01 19 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.13803717	-112.330176	Yes	USGS 2010b	
401	NWIS-2	360121111591900		Cottonwood 4 at Cottonwood Creek near Grand Canyon		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.02248369	-111.989331	No	USGS 2010b	
402	STORET-1	GRCA_FIT_PIPE04	1	Pipe Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls		Contact		36.0718389	-112.1023579	No	USEPA 2010	Pipe Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Pipe Creek Drainage. Discharge from The Bright Angel Shale-Muav Limestone Contact Fluctuates, with Higher Flow Occurring March Through May. Samples Were Colle

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
402	Liebe-03	P-UP	2	Pipe Sp; sampled at first visible water bearing spot at small nearby creek east of Bright Angel Fault		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls Contact				36.071667	-112.101667	Yes	Liebe 2003	Sampled at First Visible Water Bearing Point of Small Nearby Creek East of Bright Angel Fault; Issue Probably at Redwall-Muav Limestone Contact; Elevation 3964 Feet Above Mean Sea Level; Discharge at Pipe Spring 0.92 Gpm According to Personal Communicatio
402	Liebe-03	P-DOWN	3	Pipe Spring; sampled approximately 165' downstream from Pipe Up		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls Contact				36.07207	-112.10182	Yes	Liebe 2003	Sampled Approximately 165 Feet Downstream from The Pipe Stream (Pipe Up) Sample Site; Discharge at Pipe Spring 0.92 Gpm According to Personal Communication Between Liebe and R.D. Foust in October of 2002
402	NWIS-2	360410112055700	4	A-31-03 18 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.07081629	-112.1023907	Yes	USGS 2010b	
402	Fitz-96	PIPE	5	Pipe Creek / Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault		36.070667	-112.0981667	Yes	Fitzgerald 1996	
403	Liebe-03	H-UP	1	Horn Creek at base of Redwall-Muav Limestone contact		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls Contact				36.07802	-112.14559	Yes	Liebe 2003	Sample Taken Right at Issue of Horn Creek at The Base of The Redwall-Muav Limestone Contact; Elevation 4074 Feet Above Mean Sea Level
403	Liebe-03	H-DOWN	2	Horn Creek approximately 100' downstream from Horn Up		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls				36.07827	-112.14521	Yes	Liebe 2003	Sample Taken Approximately 100 Feet Downstream from Horn Up Sampling Location
404	GCNP-1	PIPE005	1	Burro Spring Source		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.076637548	-112.100341433	Yes	Grand Canyon National Park 2010a	
404	STORET-1	GRCA_FIT_PIPE03	2	Burro Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Contact		36.0766445	-112.1010173	No	USEPA 2010	Burro Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Pipe Creek Drainage, at The Tonto Trail. The Spring Discharges from The Bright Angel Shale-Muav Limestone Contact and Flow is Constant on An Annual Basis. Ab
404	Fitz-96	BURR	3	Burro Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault		36.076671	-112.101	Yes	Fitzgerald 1996	
404	NWIS-2	360437112060210	4	BA24 Burro Spring at Tonto Trail		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.07692737	-112.1012796	Yes	USGS 2010b	
404	Liebe-03	B-DOWN	5	Burro Spring; sampled approximately 150' downstream of Burro Up		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.07662	-112.10024	Yes	Liebe 2003	Sampled Approximately 150 Feet Below The Burro Spring (B-Up) Sampling Site;
404	Liebe-03	B-UP	6	Burro Spring; 0.6 miles east of Pipe Spring on Tonto hiking trail		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.076667	-112.099722	Yes	Liebe 2003	Sample Site Located 0.6 Miles East of Pipe Spring on The Tonto Hiking Trail; Spring Discharge is 4.94 Gpm According to Personal Communication Between Liebe and R.D. Foust in October of 2002; Sampled at First Visible Water Bearing Point

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
405	Liebe-03	H-WEST		Horn West Spring; small dripping spring sampled directly at issue at Redwall-Muav Limestone contact		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall-Muav Ls contact				36.08029	-112.15057	Yes	Liebe 2003	Most Westward Sample of Lieve'S Research Program, Horn West is a Small Dripping Spring Sampled Directly at Issue at The Redwall-Muav Limestone Contact; Elevation 4061 Feet Above Mean Sea Level
406	NWIS-2	09402450	1	Cottonwood Spring abv the Confluence with Cotton		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0235948	-111.9882199	Yes	USGS 2010b	
406	NWIS-2	360057111593101	2	Cottonwood Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.01581697	-111.9926644	No	USGS 2010b	
406	STORET-1	GRCA_FIT_ COTT04	3	Cottonwood Creek at USGS Gaging Station		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0235306	-111.9882389	No	USEPA 2010	Cottonwood Creek is Located in The South Rim Within The Boundary of Grand Canyon National Park. Samples Were Collected and Measurements Were Made at The Usgs Stream Gage (Station Number 09402450). Abundant Riparian Vegetation and Plant Waste Are Present I
406	GCNP-1	COTT004	4	Cottonwood Creek at Gage		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0235306	-111.9882389	Yes	Grand Canyon National Park 2010a	
406	Monroe-05	360128111591502	5	Cottonwood Creek No. 2 (Cottonwood Spring); mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Alluvium				36.0170585342	-111.990420019	Yes	Monroe et al. 2005	
406	Fitz-96	COTT	6	Cottonwood Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault		36.021667	-111.98833	Yes	Fitzgerald 1996	
407	Fitz-96	HORN	1	Horn Creek / Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent			36.08462	-112.14128	Yes	Fitzgerald 1996	
407	STORET-1	GRCA_FIT_ HORN03	2	Horn Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.085833	-112.144333	No	USEPA 2010	Horn Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Horn Creek Drainage. Samples Collected from The Inner-Basin Sediment. at High Flow Regimes Samples Were Collected About 3/4 Mile Up The Drainage from The Tont
407	NWIS-2	360443112083300	3	A-31-02 11 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.08053824	-112.1440587	Yes	USGS 2010b	
408	STORET-1	GRCA_FIT_ GRAP09	1	Grapevine Hell Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring		Intermittent			36.04115	-112.0229417	No	USEPA 2010	Grapevine 'Hell' Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Grapevine Creek Drainage. The Spring is Dry The Majority of The Time and Abundant Salt Precipitate Occurs Around The Orifice. Grapevine 'Hell' Spr
408	Fitz-96	GRAP-HELL	2	Grapevine Hell Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh	Intermittent			36.04115	-112.022942	Yes	Fitzgerald 1996	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
409	STORET-1	GRCA_FIT_ HERM05	1	Hawaii Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls	Perennial			36.0706411	-112.2190538	No	USEPA 2010	Hawaii Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Hermit Creek Drainage. The Spring Discharges from The Muav Limestone and Flow Was Constant Throughout Duration of Investigation.
409	Fitz-96	HAWA	2	Hawaii Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls	Perennial	Fault		36.071667	-112.217667	Yes	Fitzgerald 1996	
409	Monroe-05	360417112130701	3	Hawaii Spring; mid Bright Angel (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh				36.068819616	-112.218300795	Yes	Monroe et al. 2005	
409	NWIS-2	360417112130701	4	A-31-02 18 1 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.0713713	-112.2193385	Yes	USGS 2010b	
410	STORET-1	GRCA_FIT_ GRAP08	1	Grapevine Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls		Contact		36.023167	-112.013167	No	USEPA 2010	Grapevine Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Upper Reaches of The Grapevine Creek Drainage, 1 to 3 Miles Above The Tonto Trail. The Spring Discharges from The Bright Angel Shale-Muav Limestone Conta
410	Fitz-96	GRAP	2	Grapevine Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Perennial	Fault		36.0231667	-112.0131667	Yes	Fitzgerald 1996	
411	STORET-1	GRCA_FIT_ CREM02	1	Sam Magee Spring (Cremation East)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls				36.0774974	-112.0631939	No	USEPA 2010	Sam Macgee Spring (Aka Cremation Creek East Spring) is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Eastern Cremation Creek Drainage. The Spring Discharges at a Very Low Rate from The Bright Angel Shale-Muav Limestone
411	GCNP-1	CREM002	2	Cremation far east spring, 'Sam Macgee'		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.077464648	-112.06307739	Yes	Grand Canyon National Park 2010a	
411	Fitz-96	SAMM	3	Sam Magee Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent	Contact; Fold axis		36.078833	-112.065	Yes	Fitzgerald 1996	
411	NWIS-2	360442112034710	4	BA23 Cremation Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.07831644	-112.0637786	No	USGS 2010b	
412	STORET-1	GRCA_FIT_ HERM09	1	Hermit Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Temple Butte Ls				36.0645	-112.225167	No	USEPA 2010	Hermit Source Spring Hawaii Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Hermit Creek Drainage. Hermit Creek Drainage. Initial Discharge Occurs from The Temple Butte Limestone with No Significant Stream Flow
412	Fitz-96	HERM	2	Hermit Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Redwall Ls	Perennial	Fault		36.0645	-112.225167	Yes	Fitzgerald 1996	
412	Monroe-05	360417112130702	3	Hermit Spring; lower Muav near Bright Angel contact (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls		Contact		36.0613648137	-112.224899832	Yes	Monroe et al. 2005	
412	NWIS-1	360336112131801	4	Hermit Spring; A-31-02 19 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.06008333	-112.22169444	Yes	USGS 2009a	
413	GCNP-1	MONU003	1	Monument Creek at source spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav LS/BA Sh				36.0656137	-112.1763915	Yes	Grand Canyon National Park 2010a	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
413	Monroe-05	360455112111002	2	Monument Spring; lower Muav near Bright Angel contact (bedrock)		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls		Contact		36.063789907	-112.175640307	Yes	Monroe et al. 2005	
413	NWIS-2	360356112103201	3	A-31-02 16 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0819269	-112.1868377	Yes	USGS 2010b	
414	STORET-1	GRCA_GS2_ TURQ03		Turquoise Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1264131	-112.3385656	No	USEPA 2010	Turquoise Spring Emerges from The Upper Muav Limestone Near The Confluence of The Three Upper Branches of Turquoise Creek. The Site is Within The Boundary of Grand Canyon National Park.
415	NPS_All_Hydro	BA-3k				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0994683606	-112.247231931	No	Grand Canyon National Park 2010b	
416	NPS_All_Hydro	BA-7		Fourmile Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0737382102	-112.210233196	No	Grand Canyon National Park 2010b	
417	NPS_All_Hydro	BA-62				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.0899582611	-112.15695913	No	Grand Canyon National Park 2010b	
418	NPS_All_Hydro	HP-10				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1876912242	-112.332743536	No	Grand Canyon National Park 2010b	
419	NPS_All_Hydro	HP-10b				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1868318175	-112.33075996	No	Grand Canyon National Park 2010b	
420	NPS_All_Hydro	HP-15				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1768037981	-112.33455179	No	Grand Canyon National Park 2010b	
421	NPS_All_Hydro	HP-15c				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1765754635	-112.331521322	No	Grand Canyon National Park 2010b	
422	NPS_All_Hydro	HP-15e				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1786165159	-112.323621859	No	Grand Canyon National Park 2010b	
423	NPS_All_Hydro	HP-18a				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1693754312	-112.323407664	No	Grand Canyon National Park 2010b	
424	NPS_All_Hydro	HP-20				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1606147287	-112.324993716	No	Grand Canyon National Park 2010b	
425	NPS_All_Hydro	HP-20a				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1558010427	-112.325411427	No	Grand Canyon National Park 2010b	
426	NPS_All_Hydro	HP-20b				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1578347	-112.327318471	No	Grand Canyon National Park 2010b	
427	NPS_All_Hydro	HP-22b				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1414116465	-112.324439617	No	Grand Canyon National Park 2010b	
428	NPS_All_Hydro	HP-22c				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.140303416	-112.327036831	No	Grand Canyon National Park 2010b	
429	NPS_All_Hydro	HP-23				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1440819236	-112.304979447	No	Grand Canyon National Park 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
430	NPS_All_Hydro	HP-24				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1356886224	-112.30009232	No	Grand Canyon National Park 2010b	
431	NPS_All_Hydro	HP-24c				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1298490541	-112.30651181	No	Grand Canyon National Park 2010b	
432	NPS_All_Hydro	HP-25				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1322365946	-112.285548699	No	Grand Canyon National Park 2010b	
433	NPS_All_Hydro	HP-25a				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1266765849	-112.290103806	No	Grand Canyon National Park 2010b	
434	NPS_All_Hydro	HP-25d				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1334675411	-112.279222433	No	Grand Canyon National Park 2010b	
435	NPS_All_Hydro	HP-27a				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.121719528	-112.276544564	No	Grand Canyon National Park 2010b	
436	NPS_All_Hydro	HP-27c				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1172320779	-112.281815883	No	Grand Canyon National Park 2010b	
437	NPS_All_Hydro	HP-27d				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1241722735	-112.269918411	No	Grand Canyon National Park 2010b	
438	NPS_All_Hydro	HP-27e				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1241074418	-112.267039594	No	Grand Canyon National Park 2010b	
439	NPS_All_Hydro	HP-27g				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.124259704	-112.263899975	No	Grand Canyon National Park 2010b	
440	NPS_All_Hydro	HP-27h				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1242701347	-112.2583795	No	Grand Canyon National Park 2010b	
441	NPS_All_Hydro	HP-65b				South Buffer	Grand Canyon - South Rim	Regional	Spring					36.1780047347	-112.459314565	No	Grand Canyon National Park 2010b	
442	NPS_All_Hydro	VT-10		O' Neill Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.0175105715	-111.977750482	No	Grand Canyon National Park 2010b	Formation assigned from M&A1998
443	GCNP-1	GARD004	1	Two Tree Spring at Gage near Pumphouse		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Bright Angel Sh				36.078339568	-112.126405567	Yes	Grand Canyon National Park 2010a	
443	M&A-93b	IG	2	Indian Garden Creek at pump house		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Redwall-Muav Aquifer				36.078889	-112.126944	Yes	M&A 1993b	
443	Liebe-03	IG-UP	3	Indian Garden Creek; sidestream near pumphouse station at campground		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Muav Ls				36.078333	-112.125833	Yes	Liebe 2003	Sample Taken at Smaller Sidestream Near Pumphouse Station at Campground; Elevation 3812 Feet Above Mean Sea Level; 3380 Feet Below South Rim
443	Liebe-03	IG-DOWN	4	Indian Garden Creek; 100' Downstream from Indian Garden Up site		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Muav Ls				36.07865	-112.12581	Yes	Liebe 2003	Sample Taken 100 Feet Downstream from Ig Up; Next to Bright Angel Trail
443	NWIS-2	360441112073202	5	A-31-02 12 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Regional	Spring stream					36.07803835	-112.1262803	No	USGS 2010b	
443	Monroe-05	360441112073202	6	Pumphouse Wash Gage; mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	Alluvium				36.0764501593	-112.125633426	Yes	Monroe et al. 2005	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
444	Liebe-03	H-EA		Horn Creek at potential downstream flow of Horn Creek Up and Down sites		South Buffer	Grand Canyon - South Rim	Regional	Stream	Redwall-Muav Ls				36.08325	-112.14364	Yes	Liebe 2003	Sample Taken at Potential Downstream Flow of Horn Creek Up and Horn Creek Down; 400 Foot Vertical Elevation Difference
446	Taylor-04	HANCE-RP-SP		Hance Rapid Spring		South Buffer	Grand Canyon - East	Below regional	Spring	Quartzite/schist				36.0538703487	-111.9229303567	Yes	Taylor et al. 2004	Reported Location Utm (416872,3990117)
447	STORET-1	GRCA_NPS_ TANN02		Tanner Canyon Spring		South Buffer	Grand Canyon - East	Below regional	Spring					36.0903056	-111.8266167	No	USEPA 2010	Tanner Canyon is Located Within The Boundary of Grand Canyon National Park Near Colorado River Mile 69 at River Left. The Actual Location of The Spring in Tanner Canyon is Not Known and The Given Location is General Location in Central Tanner Canyon. Not
448	NPS_All_Hydro	BA-12				South Buffer	Grand Canyon - East	Below regional	Spring					36.0684456344	-112.020726718	No	Grand Canyon National Park 2010b	
449	NPS_All_Hydro	VT-25				South Buffer	Grand Canyon - East	Below regional	Spring					36.0849853259	-111.854887905	No	Grand Canyon National Park 2010b	
450	NPS_All_Hydro	VT-51				South Buffer	Grand Canyon - East	Below regional	Spring					36.0458822944	-111.927153193	No	Grand Canyon National Park 2010b	
451	Monroe-05	360411112141701	1	Boucher East Spring; upper Tapeats (travertine dome)		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss				36.1007013515	-112.237245484	Yes	Monroe et al. 2005	
451	NWIS-2	360411112141701	2	A-31-01 01 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Bright Angel Sh				36.06970456	-112.2387835	Yes	USGS 2010b	
452	NWIS-2	360513112044001		A-31-03 15 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.0869274	-112.0785013	Yes	USGS 2010b	
453	STORET-1	GRCA_FIT_ LONE02	1	Lonetree Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh		Contact		36.0715972	-112.0460028	No	USEPA 2010	The Lower Lonetree Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in Lonetree Canyon. The Spring Discharges from The Tapeats Sandstone-Bright Angle Shale Contact But The Actual Spring Orifice is Buried By Modern Sedim
453	GCNP-1	LONE002	2	Lonetree near Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss				36.0715972	-112.0460028	Yes	Grand Canyon National Park 2010a	
453	Fitz-96	LONE	3	Lonetree Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	U. Tapeats Ss	Intermittent	Fold axis		36.0711667	-112.0455	Yes	Fitzgerald 1996	
453	NWIS-2	360418112024710	4	BA22 Lonetree Spring at Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Bright Angel Sh				36.07164988	-112.0471113	No	USGS 2010b	
454	STORET-1	GRCA_FIT_ BLDR03	1	Boulder Creek Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent			36.056187	-112.0350906	No	USEPA 2010	Boulder Creek Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Boulder Creek Drainage. The Spring Flows from The Tapeats Sandstone Near The Tonto Trail and is Dry The Majority of The Time.
454	Fitz-96	BLDR	2	Boulder Creek (Spring)		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent			36.056187	-112.035091	Yes	Fitzgerald 1996	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
454	GCNP-1	BLDR003	3	Boulder Creek		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent			36.056187	-112.0350906	Yes	Grand Canyon National Park 2010a	Coord from Storet Grca_Nps_ Bldr03; Spring Flows from The Tapeats Sandstone Near The Tonto Trail and is Dry The Majority of The Time.
455	Fitz-96	CEDA	1	Cedar Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh	Intermittent			36.08974	-112.17856	Yes	Fitzgerald 1996	
455	GCNP-1	CEDR002	2	Cedar Spring below Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss				36.089741669	-112.17893611	Yes	Grand Canyon National Park 2010a	
455	STORET-1	GRCA_FIT_ CEDR02	3	Cedar Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh		Contact		36.0888932	-112.1780801	No	USEPA 2010	Cedar Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Drainage East of Monument Creek. The Spring Discharges from The Tapeats Sandstone-Bright Angel Shale Contact Near The Tonto Trail and is Dry in The Summer Mo
456	STORET-1	GRCA_FIT_ COTT08	1	Cottonwood West Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent			36.0368578	-111.9974578	No	USEPA 2010	Cottonwood West Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Far Western Tributary of Cottonwood Creek. The Spring Discharges a Small Volume Intermittently from The Tapeats Sandstone.
456	Fitz-96	COTT-W	2	Cottonwood West Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh	Intermittent			36.036858	-111.9974578	Yes	Fitzgerald 1996	
456	GCNP-1	COTT006	3	Cottonwood Far West		South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.036792	-111.99749	Yes	Grand Canyon National Park 2010a	
457	Fitz-96	MONU	1	Monument Creek / Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	U. Tapeats Ss	Intermittent			36.08233	-112.185667	Yes	Fitzgerald 1996	
457	STORET-1	GRCA_FIT_ MONU05	2	Monument Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss - Bright Angel Sh		Contact		36.082333	-112.185667	No	USEPA 2010	Monument Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Monument Creek Drainage, Near The Tonto Trail. The Spring Discharges from The Tapeats Sandstone-Bright Angel Shale Contact. Samples Were Collected from Th
457	NWIS-2	360455112110800	3	A-31-02 09 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss				36.0819269	-112.1868377	Yes	USGS 2010b	
458	STORET-1	GRCA_FIT_ CREM03	1	Cremation Creek Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring		Intermittent			36.08345	-112.0697111	No	USEPA 2010	Cremation Creek Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Cremation Creek Drainage. The Spring is Dry The Majority of The Time and Abundant Salt Precipitate Occurs in The Creek Bed. Cremation Creek Spring
458	Fitz-96	CREM	2	Cremation Creek (Spring)		South Buffer	Grand Canyon - South Rim	Below regional	Spring	Tapeats Ss	Intermittent			36.08345	-112.0697111	Yes	Fitzgerald 1996	
459	GCNP-1	LONE004		Lonetree at Lone Cottonwood		South Buffer	Grand Canyon - South Rim	Below regional	Spring	PC meta/ig				36.07425	-112.0407	Yes	Grand Canyon National Park 2010a	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
460	NHD-1	128914664				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1454106106	-112.318941469	No	USGS 2007	
461	NPS_All_Hydro	BA-1				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1273190532	-112.243557402	No	Grand Canyon National Park 2010b	
462	NPS_All_Hydro	BA-3c				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1132271743	-112.237224435	No	Grand Canyon National Park 2010b	
463	NPS_All_Hydro	BA-5				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1009600759	-112.219865206	No	Grand Canyon National Park 2010b	
464	NPS_All_Hydro	BA-5b				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1028039087	-112.219017491	No	Grand Canyon National Park 2010b	
465	NPS_All_Hydro	HP-15f				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.180294871	-112.322650977	No	Grand Canyon National Park 2010b	
466	NPS_All_Hydro	HP-20c				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1596295715	-112.319277781	No	Grand Canyon National Park 2010b	
467	NPS_All_Hydro	HP-21				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1596013862	-112.315340641	No	Grand Canyon National Park 2010b	
468	NPS_All_Hydro	HP-22				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1432250779	-112.322698606	No	Grand Canyon National Park 2010b	
469	NPS_All_Hydro	HP-22a				South Buffer	Grand Canyon - South Rim	Below regional	Spring					36.1504991513	-112.314366348	No	Grand Canyon National Park 2010b	
470	GCNP-1	PIPE003	1	Burro Spring below Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring stream	Tapeats Ss				36.076970284	-112.102883686	Yes	Grand Canyon National Park 2010a	
470	NWIS-2	360436112060401	2	A-31-03 17 UNSURVEYED		South Buffer	Grand Canyon - South Rim	Below regional	Spring stream	Bright Angel Sh				36.07664959	-112.1018352	Yes	USGS 2010b	
470	Monroe-05	360436112060401	3	Burro Spring; lower Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	Below regional	Spring stream	Alluvium				36.0748218335	-112.100268106	Yes	Monroe et al. 2005	
471	Hom-86	Orph-Adit		Orphan Lode Mine Adit		South Buffer	Grand Canyon - South Rim	Mine seepage	Shaft	Coconino Ss				36.07258	-112.14976	Yes	Hom 1986	Sample location is 1.5-inch pipe from old piping system exposed at cliff face between two mine adits
472	Monroe-05	360415112060601	1	Pipe Creek; lower Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium				36.0675159426	-112.099183347	Yes	Monroe et al. 2005	
472	NWIS-2	09403010	2	Pipe Spring Creek above Tonto Trail near Grand Canyon, AZ		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.0719274	-112.1021129	Yes	USGS 2010b	
472	GCNP-1	PIPE002	3	Pipe Creek above Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	Bright Angel Sh				36.071106394	-112.101841251	Yes	Grand Canyon National Park 2010a	
473	NWIS-2	09403015		Garden Creek below Indian Garden near Grand Canyon, AZ		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.0833161	-112.1243359	Yes	USGS 2010b	
474	GCNP-1	HERM004	1	Hermit Creek at gage		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss				36.080597227	-112.214152776	Yes	Grand Canyon National Park 2010a	
474	NWIS-2	09403043	2	Hermit Creek above Tonto Trail near Grand Canyon, AZ		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.08081566	-112.2137829	Yes	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
475	GCNP-1	MONU002	1	Monument Creek at Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	PC Meta/Ig				36.0818938	-112.1862363	Yes	Grand Canyon National Park 2010a	
475	NWIS-2	09403033	2	Monument Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.0833333	-112.186111	Yes	USGS 2010b	
476	Liebe-03	IG-CC		Indian Garden Creek; 600' Upstream from Mixing Confluence site		South Buffer	Grand Canyon - South Rim	N/A	Stream	Muav Ls				36.092778	-112.111389	Yes	Liebe 2003	Sample Taken 600 Feet Upstream from The Mixing Confluence of Unnamed Crystalline Core Stream and Garden Creek; Elevation 2654 Feet Above Mean Sea Level
477	Liebe-03	MC		Confluence of unnamed crystalline core stream and Garden Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.0941	-112.11194	Yes	Liebe 2003	Sample Taken at Mixing Confluence of Unnamed Crystalline Core Creek and Garden Creek; Sampled Three Times Between July 15 - August 16, 2002 Downstream from Mixing Point One Mile Upstream from Confluence with Colorado River; Elevation 2588 Feet Above Mean
478	Liebe-03	UCC		Pipe Ck basin; exposed, remote point directly above 100' waterfall		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss				36.08848	-112.11283	Yes	Liebe 2003	Spring Issues at Indian Garden Campground, Meanders Through Tapeats Sandstone and Inner Gorge Into Colorado River; Collects Water Along The Way from this Unnamed Spring, Which Issues Below The Base of Tapeats Sandstone Where Garden Creek and Pipe Creek Me
479	Liebe-03	P-CC		Pipe Creek; 0.8 miles upstream from mixing confluence in Pipe Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.08495	-112.10861	Yes	Liebe 2003	Pipe Creek in The Inner Gorge; Samples 0.8 Miles Upstream from Mixing Confluence in Pipe Creek; Water Barely Visible at this Site; Samples Collected By Damming Water Before Sampling; Elevation 3113 Feet Above Mean Sea Level
480	STORET-1	GRCA_FIT_ SALT02	1	Salt Creek at the Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss				36.0849333	-112.1626083	No	USEPA 2010	Salt Creek Spring is Located in The South Rim Within The Boundary of Grand Canyon National Park in The Salt Creek Drainage, Near The Tonto Trail. The Seeps Flow from The Tapeats Sandstone, Mainly from An Opening in Cross-Bedding.
480	GCNP-1	SALT002	2	Salt Creek Below Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss				36.084992657	-112.162621723	Yes	Grand Canyon National Park 2010a	
480	Fitz-96	SALT	3	Salt Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream	Tapeats Ss	Intermittent	Bedding Planes		36.08533	-112.161833	Yes	Fitzgerald 1996	
481	GCNP-1	BLDR002		Boulder canyon above the Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.056906141	-112.036262236	Yes	Grand Canyon National Park 2010a	
482	GCNP-1	BOUC006		Boucher near Tonto Trail/ Campsites		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.106472898	-112.239983348	Yes	Grand Canyon National Park 2010a	
483	GCNP-1	GRAP005		Grapevine Canyon at Tonto trail		South Buffer	Grand Canyon - South Rim	N/A	Stream					36.036281832	-112.022078227	Yes	Grand Canyon National Park 2010a	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
484	GCNP-1	HORN002	1	Horn Creek at Phone (or power) lines		South Buffer	Grand Canyon - South Rim	N/A	Stream	Bright Angel Sh				36.0785692	-112.1432629	Yes	Grand Canyon National Park 2010a	
484	Monroe-05	360450112083601	2	Horn Creek; mid Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium				36.0786398318	-112.142948991	Yes	Monroe et al. 2005	
485	GCNP-1	MONU004		Monument Creek at Monument		South Buffer	Grand Canyon - South Rim	N/A	Stream	PC Meta/Ig				36.0844444	-112.1886111	Yes	Grand Canyon National Park 2010a	
486	Monroe-05	360128111591501		Cottonwood Creek No. 1; lower Bright Angel alluvium		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium				36.022599929	-111.986669592	Yes	Monroe et al. 2005	
487	Monroe-05	360455112111001		Monument Creek No. 1; Tapeats (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	Alluvium				36.0800700272	-112.185485369	Yes	Monroe et al. 2005	
488	NWIS-2	354345111551901		A-27-04 13BBB		South Buffer	Coconino Plateau - East	N/D	Well					35.7291616	-111.9226591	No	USGS 2010b	
489	NURE	23088				South Buffer	Coconino Plateau - East	N/D	Well					35.958084792	-112.395732047	Yes	USGS 2009b	
490	NWIS-2	355142111234301		03 98-07.70X09.60			Cameron, AZ	Mesozoic	Spring					35.86166216	-111.3959763	Yes	USGS 2010b	
491	NWIS-2	355326111243501		03 98-09.05X07.63			Cameron, AZ	Mesozoic	Spring					35.89055046	-111.4104205	No	USGS 2010b	
492	NWIS-2	355141111234301		03-098 08.13X09.52			Cameron, AZ	Mesozoic	Spring	Shinarump Mbr				35.86138438	-111.3959763	Yes	USGS 2010b	
493	NWIS-2	355129111263301		03-098 10.79X09.72			Cameron, AZ	Mesozoic	Spring	Moenkopi Fm				35.85805107	-111.4431991	No	USGS 2010b	
494	GWSI-1	353118111223101	1	Wupatki Spring; A-25-10 30BBC			Coconino Plateau - East	Mesozoic	Spring	Moenkopi Fm	Perennial	Contact		35.521670551	-111.375983183	Yes	ADWR 2009b	
494	NWIS-2	353118111223101	2	A-25-10 30BBC			Coconino Plateau - East	Mesozoic	Spring	Moenkopi Fm				35.5216702	-111.375983	Yes	USGS 2010b	
495	NWIS-2	353021111211401		A-25-10 32BDB			Coconino Plateau - East	Mesozoic	Spring	Moenkopi Fm				35.50583715	-111.3545937	Yes	USGS 2010b	
496	GWSI-1	353328112354201		Howard Spring; B-25-03 15BBA			Coconino Plateau - West	Mesozoic	Spring					35.557774909	-112.59573477	No	ADWR 2009b	
497	NURE	23078					Coconino Plateau - West	Mesozoic	Spring					35.563596743	-112.585234644	Yes	USGS 2009b	
498	NURE	23081					Coconino Plateau - West	Mesozoic	Spring					35.641493416	-112.687238785	Yes	USGS 2009b	
499	GCWC-02	LM-4-1		Ambush Spring #1; B-31-11 22BD			Grand Canyon - West	Mesozoic	Spring	Basalt	Perennial	Contact; Fracture		36.07178	-113.45886	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, North End of Kelly Point Road, Eight Miles Southeast of Mt. Dellenbaugh Lmnra Fire Camp Cabins
500	GCWC-02	LM-4-2		Ambush Spring #2; B-31-11 22CA			Grand Canyon - West	Mesozoic	Spring	Basalt	Perennial	Fracture		36.07069	-113.45859	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, North End of Kelly Point Road, Eight Miles Southeast of Mt. Dellenbaugh Lmnra Fire Camp Cabins
501	GWSI-1	363120113193001	1	Russell Spring; B-36-10 13BCC			Hurricane Valley	Mesozoic	Spring	Coconino Ss	Perennial	Fracture		36.522203339	-113.325778085	Yes	ADWR 2009b	
501	NWIS-2	363120113193001	2	B-36-10 13BCC			Hurricane Valley	Mesozoic	Spring	Coconino Ss				36.52220356	-113.325778	No	USGS 2010b	
502	NURE	GCAC501R					Hurricane Valley	Mesozoic	Spring	MNKP Ss				36.945983511	-113.35568342	Yes	USGS 2009b	
503	BLM-Legacy	LEG-201		Coyote Spring; B-41-10 22CDB			Hurricane Valley	Mesozoic	Spring					36.93639	-113.36496	Yes	BLM 2010d	Piped Off at Source/Overflow to Pond from Trough
504	BLM-Legacy	LEG-46		Russel Spring; B-36-10 13CA			Hurricane Valley	Mesozoic	Spring					36.52015	-113.31962	Yes	BLM 2010d	Seep from a Cave Pool/Subject to Flash Floods/Atkins Feel It is Not Worth Fixing
505	GCWC-02-Map	M-378		Sand Spring; B-41-10 22BAA			Hurricane Valley	Mesozoic	Spring					36.94578	-113.36237	No	Grand Canyon Wildlands Council 2002	
506	NWIS-2	365853112380901	1	Wolf Spring; B-41-03 05 UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Petrified Forest Mbr				36.9813742	-112.636593	No	USGS 2010b	
506	GCWC-02-Map	M-466	2	Wolf Spring; B-41-03 05D			Kaibab Paiute Reservation	Mesozoic	Spring					36.98131	-112.63617	No	Grand Canyon Wildlands Council 2002	
507	GWSI-1	365829112360101	1	Cottonwood Spring; B-41-03 10A			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr	Perennial	Contact		36.974707625	-112.601036649	No	ADWR 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
507	NWIS-2	365829112360101	2	B-41-03 10ABA			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr				36.97470784	-112.6010364	Yes[3]	USGS 2010b	
508	GCWC-02-Map	M-153	1	Riggs Spring; B-41-03 16C			Kaibab Paiute Reservation	Mesozoic	Spring					36.9484	-112.62502	No	Grand Canyon Wildlands Council 2002	
508	GWSI-1	365650112372601	2	Riggs Spring; B-41-03 16C			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr	Perennial	Contact		36.947207717	-112.624647164	No	ADWR 2009b	
508	NWIS-2	365650112372601	3	B-41-03 16CDC UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr				36.9485968	-112.6254805	Yes[3]	USGS 2010b	
508	NURE	GCAF505R	4				Kaibab Paiute Reservation	Mesozoic	Spring	CHNL Ss				36.9480857	-112.625358215	Yes[3]	USGS 2009b	
509	NWIS-2	365738112390801	1	Pine Spring; B-41-03 18 UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Shinarump Mbr				36.96054097	-112.6529816	No	USGS 2010b	
509	GCWC-02-Map	M-468	2	Pine Spring; B-41-03 18AAA			Kaibab Paiute Reservation	Mesozoic	Spring					36.96028	-112.65266	No	Grand Canyon Wildlands Council 2002	
510	GCWC-02-Map	M-472	1	Point Spring; B-41-04 28D			Kaibab Paiute Reservation	Mesozoic	Spring					36.92127	-112.72314	No	Grand Canyon Wildlands Council 2002	
510	GWSI-1	365516112432201	2	Point Spring; B-41-04 28DAD			Kaibab Paiute Reservation	Mesozoic	Spring		Perennial	Fracture		36.921096241	-112.72353787	Yes[3]	ADWR 2009b	
510	NWIS-2	365516112432201	3	B-41-04 28DAC			Kaibab Paiute Reservation	Mesozoic	Spring	Moenave Fm				36.92109635	-112.7235376	No	USGS 2010b	
510	NURE	GCAF504R	4				Kaibab Paiute Reservation	Mesozoic	Spring	MNKP Ss				36.921285243	-112.722759855	Yes[3]	USGS 2009b	
511	NWIS-2	365934112412501		B-42-04 35 UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Spring	Navajo Ss				36.9927627	-112.6910392	No	USGS 2010b	
512	NURE	GCAE503R					Kaibab Paiute Reservation	Mesozoic	Spring					36.933184841	-112.82796383	Yes[3]	USGS 2009b	
513	GCWC-02-Map	M-475	1	Burnt Corral Spring; B-41-05 13ADD			Kaibab Paiute Reservation	Mesozoic	Spring					36.95547	-112.77571	No	Grand Canyon Wildlands Council 2002	
513	NURE	GCAE515R	2				Kaibab Paiute Reservation	Mesozoic	Spring	TRSS Ss				36.956084772	-112.777062589	Yes[3]	USGS 2009b	
514	NURE	GCAE516R					Kaibab Paiute Reservation	Mesozoic	Spring	TRSS Ss				36.995084509	-112.782863875	Yes[3]	USGS 2009b	
515	GCWC-02-Map	M-149	1	Red Cliff Spring; B-41-04 01AD			Kaibab Paiute Reservation	Mesozoic	Spring					36.98523	-112.68887	No	Grand Canyon Wildlands Council 2002	
515	NURE	GCAF503R	2				Kaibab Paiute Reservation	Mesozoic	Spring	MNKP Ss				36.984384997	-112.689261072	Yes[3]	USGS 2009b	
516	BLM-Legacy	LEG-234		Cane Spring; B-41-05 22CCC			Kaibab Paiute Reservation	Mesozoic	Spring					36.93324	-112.82761	Yes[3]	BLM 2010d	May Be Referred to As Bull Pasture Spring
517	BLM-Legacy	LEG-229		Hole in the Rock Spring; B-41-03 06AAC			Kaibab Paiute Reservation	Mesozoic	Spring					36.98759	-112.65374	Yes[3]	BLM 2010d	Pools 6'×6'×1',1'×6'×1'/Water Flows for 65' on Surface/Wet Area 6'×10'
518	GCWC-02-Map	M-182		Willow Spring; B-41-04 06D			Kaibab Paiute Reservation	Mesozoic	Spring					36.98017	-112.76092	No	Grand Canyon Wildlands Council 2002	
519	GCWC-02-Map	M-129		Upper Moccasin Spring; B-41-05 26C			Kaibab Paiute Reservation	Mesozoic	Spring					36.92022	-112.80643	No	Grand Canyon Wildlands Council 2002	
520	GCWC-02-Map	M-469		Auston Spring; B-41-03 30DA			Kaibab Paiute Reservation	Mesozoic	Spring					36.92382	-112.65211	No	Grand Canyon Wildlands Council 2002	
521	GCWC-02-Map	M-2		Bull Pasture Spring; B-41-05 26A			Kaibab Paiute Reservation	Mesozoic	Spring					36.93206	-112.79921	No	Grand Canyon Wildlands Council 2002	No Spring on Topo Map

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
522	Taylor-97	FOUR-MI-SP		Four Mile Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring					36.87511111	-111.5071111	Yes	Taylor et al. 1997	
523	Taylor-97	POWER-SP		Power Lines Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring	Navajo Ss				36.92697222	-111.4921111	Yes	Taylor et al. 1997	
524	Taylor-97	SEWA-SP		Sewage Ponds Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring					36.91180556	-111.4783056	Yes	Taylor et al. 1997	
525	BLM-Legacy	LEG-258	1	Cottonwood Spring; B-42-06 34DDD			Moccasin Mtns	Mesozoic	Spring					36.9908	-112.92097	Yes	BLM 2010d	
525	GWSI-1	365925112551201	2	Cottonwood Spring; B-42-06 34DDD			Moccasin Mtns	Mesozoic	Spring	Navajo Ss		Fracture		36.990262359	-112.920768349	No	ADWR 2009b	
525	NWIS-2	365925112551201	3	B-42-06 34DDD			Moccasin Mtns	Mesozoic	Spring	Navajo Ss				36.99026214	-112.9207683	No	USGS 2010b	
525	NURE	GCAE509R	4				Moccasin Mtns	Mesozoic	Spring	TRSS Ss				36.990284362	-112.92076835	Yes	USGS 2009b	
526	BLM-Legacy	LEG-238		Finnicum Seeps; B-41-06 01AC			Moccasin Mtns	Mesozoic	Spring					36.98464	-112.89053	Yes	BLM 2010d	Allotment #4026 Turned Over to Utah Blm,Dixie Resource Area/ No File on Spring Improvement at Finnicum Spring/Buried Head Box
527	BLM-Legacy	LEG-255		Finnicum Spring; B-42-06 36AA			Moccasin Mtns	Mesozoic	Spring					36.99907	-112.885	No	BLM 2010d	
528	BLM-Legacy	LEG-233		Parashont Spring; B-41-05 09DB			Moccasin Mtns	Mesozoic	Spring					36.96724	-112.83546	Yes	BLM 2010d	
529	BLM-Legacy	LEG-257		Stateline Spring; B-42-06 35BA			Moccasin Mtns	Mesozoic	Spring					36.99672	-112.90543	Yes	BLM 2010d	Development Washed Out
530	BLM-Legacy	LEG-256		Maidenhair Spring; B-42-06 35AB			Moccasin Mtns	Mesozoic	Spring					36.99936	-112.9098	Yes	BLM 2010d	Development Type: Cutoff Dike
531	NWIS-2	360840111200501		03 078-04.75X07.27			Painted Desert	Mesozoic	Spring	Navajo Ss				36.1444362	-111.3354195	Yes	USGS 2010b	
532	BLM-Legacy	LEG-231		Sand Spring; A-42-04 32C			Paria Plateau	Mesozoic	Spring					36.99764	-111.99389	Yes	BLM 2010d	Spring Was Developed in 1963 Under a.P. Sanders:Jdr #1384/ Development No Longer at Site,Or There Are Two Sand Springs
533	BLM-Legacy	LEG-235		Bush Head Canyon; A-41-06 23DA			Paria Plateau	Mesozoic	Spring					36.93845	-111.71227	Yes	BLM 2010d	Light Livestock Use
534	BLM-Legacy	LEG-236		Last Springs; A-41-06 15DD			Paria Plateau	Mesozoic	Spring					36.94897	-111.73122	Yes	BLM 2010d	Light Cattle Use/Actually Two Springs Located at Site/One Estimated at 2.5 Gallons per Minute,Other Main Spring at 1.5 Gallons per Minute
535	BLM-Legacy	LEG-240		Wilson Spring; A-41-07 34CBA			Paria Plateau	Mesozoic	Spring					36.9096	-111.63321	No	BLM 2010d	Spring is Recommended for Fencing and Gabbtons Needed in Few Spots Along River Bank/ Old (Non-Functional) Pipelines and Concrete Head Box Above Present Spring Source/No Disch
536	BLM-Legacy	LEG-237		Wrather Spring; A-41-06 08CC			Paria Plateau	Mesozoic	Spring					36.96255	-111.77967	Yes	BLM 2010d	Beaver Sighting
537	GCWC-02-Map	M-74		A-41-07 34C			Paria Plateau	Mesozoic	Spring					36.9088	-111.63337	No	Grand Canyon Wildlands Council 2002	
538	BLM-Legacy	LEG-239		A-41-07 34B (seep)			Paria Plateau	Mesozoic	Spring					36.91434	-111.63406	Yes	BLM 2010d	Spring Just Northwest of Wilson Spring/Flow Rate 5-10 Gallons per Minute/No Fences/Light Deer Use
539	GCWC-02	LM-3	1	Green Spring; B-31-11 09CD			Shivwits Plateau	Mesozoic	Spring	Basalt	Perennial	Contact		36.09415	-113.47441	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, North End of Kelly Point Road, Six Miles Southeast of Mt. Dellenbaugh Lmnra Fire Camp Cabins;
539	NWIS-2	360538113282501	2	B-31-11 09CDD			Shivwits Plateau	Mesozoic	Spring	Basaltic Flows				36.0938727	-113.4743803	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
540	NWIS-2	362340113282301	1	Ivan Patch Spring; B-35-11 33ABD			Shivwits Plateau	Mesozoic	Spring	Basaltic Flows				36.3944248	-113.473832	No	USGS 2010b	
540	BLM-Legacy	LEG-34	2	Ivan Patch Spring; B-35-11 33AB			Shivwits Plateau	Mesozoic	Spring					36.39281	-113.47293	No	BLM 2010d	10 Foot Tunnel
541	GCWC-02	BLM 151	1	Poverty Spring; B-35-12 26DC			Shivwits Plateau	Mesozoic	Spring	Moenkopi Fm		Contact		36.39852	-113.54803	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, Southwest End of Poverty Mountain, 2 Miles Northeast of Poverty Administration Site.
541	BLM-Legacy	LEG-37	2	Poverty Spring; B-35-12 26DC			Shivwits Plateau	Mesozoic	Spring					36.39852	-113.54803	Yes	BLM 2010d	Additional Jdr:4260/"Coop" Agreement on Water Amount:2/3 to Roland Esplin and 1/3 to Administration Site of 2000 Gallon Storage Tank/Spring Drains Into Parashaunt Canyon (We
541	NWIS-2	362355113325101	3	B-35-12 26DCC			Shivwits Plateau	Mesozoic	Spring	Basaltic Flows				36.39859177	-113.5482788	Yes	USGS 2010b	
542	Hopkins-84a	GW025W					Shivwits Plateau	Mesozoic	Spring					36.225259308	-113.554383554	Yes	Hopkins et al. 1984a	
543	Hopkins-84a	GW026W					Shivwits Plateau	Mesozoic	Spring					36.230814765	-113.559105995	Yes	Hopkins et al. 1984a	
544	Hopkins-84a	GW028WA					Shivwits Plateau	Mesozoic	Spring					36.145260392	-113.48799177	Yes	Hopkins et al. 1984a	
545	Hopkins-84a	GW031W					Shivwits Plateau	Mesozoic	Spring					36.224147912	-113.535771535	Yes	Hopkins et al. 1984a	
546	Hopkins-84a	GW032W					Shivwits Plateau	Mesozoic	Spring					36.246924441	-113.501325446	Yes	Hopkins et al. 1984a	
547	NURE	GCCC501R					Shivwits Plateau	Mesozoic	Spring	QTRN Volcanics - Mafic				36.382780368	-113.462575645	Yes	USGS 2009b	
548	GCWC-02	BLM 152	1	Dewdrop Spring; B-35-12 36BA			Shivwits Plateau	Mesozoic	Spring	Moenkopi Fm - Q Landslide		Contact		36.39472	-113.53114	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, South End of Poverty Mountain, 3 Miles East of Poverty Administration Site.
548	BLM-Legacy	LEG-36	2	Dewdrop Spring; B-35-12 36BA			Shivwits Plateau	Mesozoic	Spring					36.39472	-113.53114	Yes	BLM 2010d	Spring Drains Into Parashaunt Canyon (West Fork)
549	GCWC-02	BLM 163	1	Salt Spring; B-34-11 06CD			Shivwits Plateau	Mesozoic	Spring	Moenkopi Fm	Perennial	Contact		36.37146	-113.51327	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, South End of Poverty Mountain, 4 Miles Southeast of Poverty Administration Site.
549	BLM-Legacy	LEG-16	2	Salt Spring; B-34-11 06CD			Shivwits Plateau	Mesozoic	Spring					36.37146	-113.51327	Yes	BLM 2010d	Headbox Rusted Out/System Non-Functional/Large Storage Tank
550	GCWC-02	GCNP-109		Deer Creek new river; B-35-02 28D			Shivwits Plateau	Mesozoic	Spring	Tapeats Ss	Intermittent	Contact		36.38853	-113.50917	Yes	Grand Canyon Wildlands Council 2002	in Deer Creek Canyon, Approximately 1.1 Miles from The Colorado River at River Mile 136.3
551	BLM-Legacy	LEG-35		New Spring; B-35-11 20DB			Shivwits Plateau	Mesozoic	Spring					36.41674	-113.49562	Yes	BLM 2010d	Tunneled Into Formation Approximately 100 Feet
552	GCWC-02-Map	M-285		Dead Drop Spring? Dewdrop Spring; B-35-11 31			Shivwits Plateau	Mesozoic	Spring					36.39328	-113.51496	No	Grand Canyon Wildlands Council 2002	
553	BLM-Legacy	LEG-8		Andrus Lower Spring; B-33-11 20CA			Shivwits Plateau	Mesozoic	Spring					36.24286	-113.50366	Yes	BLM 2010d	
554	BLM-Legacy	LEG-9		Andrus Upper Spring; B-33-11 20CA			Shivwits Plateau	Mesozoic	Spring					36.24424	-113.50365	Yes	BLM 2010d	
555	BLM-Legacy	LEG-11		Log Spring/Pond; B-33-12 35AD			Shivwits Plateau	Mesozoic	Spring					36.219	-113.5425	No	BLM 2010d	Spring Drains Into Parashaunt Canyon (East Fork)

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
556	GCWC-02-Map	M-219		B-33-12 35AA			Shivwits Plateau	Mesozoic	Spring					36.22285	-113.54312	No	Grand Canyon Wildlands Council 2002	No Spring on Topo
557	GWSI-1	365654113032001	1	Lost Spring; B-41-07 16CDD			Uinkaret Plateau - North	Mesozoic	Spring	Shinarump Mbr		Contact		36.948317453	-113.056328745	Yes	ADWR 2009b	
557	BLM-Legacy	LEG-241	2	Lost Spring; B-41-07 16CDD			Uinkaret Plateau - North	Mesozoic	Spring					36.94861	-113.05604	Yes	BLM 2010d	
557	NWIS-2	365654113032001	3	B-41-07 16CDD			Uinkaret Plateau - North	Mesozoic	Spring	Shinarump Mbr				36.94831779	-113.0563283	No	USGS 2010b	
557	NURE	GCAD503R	4				Uinkaret Plateau - North	Mesozoic	Spring	TRSS Ss				36.948384455	-113.056372748	Yes	USGS 2009b	
558	NURE	GCAD513R					Uinkaret Plateau - North	Mesozoic	Spring					36.931184475	-113.123975451	Yes	USGS 2009b	
559	BLM-Legacy	LEG-245		Lytle Spring; B-41-08 29CD			Uinkaret Plateau - North	Mesozoic	Spring					36.91897	-113.185	Yes	BLM 2010d	Spring Flow is .04 Gallons per Minute
560	BLM-Legacy	LEG-243		Upper Lytle Spring; B-41-09 25ACA			Uinkaret Plateau - North	Mesozoic	Spring					36.92798	-113.21443	Yes	BLM 2010d	Flow is .019 Gallons per Minute/ Barely a Seep
561	BLM-Legacy	LEG-244		Wells Spring; B-41-08 11DDB			Uinkaret Plateau - North	Mesozoic	Spring					36.96393	-113.12226	Yes	BLM 2010d	
562	BLM-Legacy	LEG-246		Cottonwood Spring; B-41-09 25BA			Uinkaret Plateau - North	Mesozoic	Spring					36.9321	-113.21923	Yes	BLM 2010d	
563	GCWC-02-Map	M-133		B-42-07 31B			Uinkaret Plateau - North	Mesozoic	Spring					36.99911	-113.0997	No	Grand Canyon Wildlands Council 2002	
564	GWSI-1	362038113090101	1	Little Spring; B-34-08 16DAC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows		Contact		36.343870153	-113.151043857	Yes	ADWR 2009b	
564	NWIS-2	362038113090101	2	B-34-08 16DAC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows				36.34387004	-113.1510436	No	USGS 2010b	
564	BLM-Legacy	LEG-26	3	Little Spring; B-34-08 16DBD			Uinkaret Plateau - South	Mesozoic	Spring					36.34383	-113.15127	Yes	BLM 2010d	Also Known As Little Oak Spring
565	GWSI-1	362014113112501	1	Big Spring; B-34-08 19ABC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows	Perennial	Contact		36.337203071	-113.191045475	No	ADWR 2009b	
565	NWIS-2	362014113112501	2	B-34-08 19ABC			Uinkaret Plateau - South	Mesozoic	Spring	Basaltic Flows				36.3372033	-113.1910453	Yes	USGS 2010b	
565	BLM-Legacy	LEG-27	3	Big Springs; B-34-08 19ABD			Uinkaret Plateau - South	Mesozoic	Spring					36.33694	-113.19096	No	BLM 2010d	
565	NURE	GCCD502R	4				Uinkaret Plateau - South	Mesozoic	Spring	UNKN Volcanics -Mafic				36.335681071	-113.190567408	Yes	USGS 2009b	
566	GCWC-02	BLM 179	1	Death Valley Spring; B-34-09 04DB			Uinkaret Plateau - South	Mesozoic	Spring	Qal alluvial deposits		Unknown; contact?		36.37306	-113.26194	Yes	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, Sawmill Mountains, 6 Miles Southwest of Mt. Trumbull
566	BLM-Legacy	LEG-33	2	Death Valley Spring; B-34-09 04DB			Uinkaret Plateau - South	Mesozoic	Spring					36.37306	-113.26194	No	BLM 2010d	Pipeline Broken
566	NURE	GCCC503R	3				Uinkaret Plateau - South	Mesozoic	Spring	KBBL Carbonate				36.373581039	-113.261571561	Yes	USGS 2009b	
567	GCWC-02	BLM 180	1	Cold Spring; B-34-09 09CDA			Uinkaret Plateau - South	Mesozoic	Spring	Basalt	Perennial	Fracture		36.35693	-113.26422	Yes	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, South Slope of Sawmill Mountains, 6.5 Miles Southwest of Mt. Trumbull
567	BLM-Legacy	LEG-30	2	Cold Spring; B-34-09 09CDA			Uinkaret Plateau - South	Mesozoic	Spring					36.35693	-113.26422	Yes	BLM 2010d	Unmaintained for Years
568	GCWC-02	BLM 600		Mount Trumbull Basalt Spring; B-34-08 04BB			Uinkaret Plateau - South	Mesozoic	Spring	Basalt	Ephemeral	Fracture		36.37893	-113.16181	Yes	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau, One Mile South of Mt. Trumbull Administrative Site Abutting a Basalt Flow
569	BLM-Legacy	LEG-29		Lava Spring; B-34-08 04BBA			Uinkaret Plateau - South	Mesozoic	Spring					36.38089	-113.16097	No	BLM 2010d	Emerges at Base of a Recent Basalt Flow/Full Grown Mountain Lion Seen at Spring
570	BLM-Legacy	LEG-32		Randall Spring; B-34-09 13BD			Uinkaret Plateau - South	Mesozoic	Spring					36.3479	-113.21171	No	BLM 2010d	
571	BLM-Legacy	LEG-31		Sawmill Tank Spring; B-34-09 12BB			Uinkaret Plateau - South	Mesozoic	Spring					36.36762	-113.21478	Yes	BLM 2010d	Water is Also Piped from Tank to Private Land Approximately 1 Mile/No Information on Exact Location/Jdr# to It is 4959
572	GCWC-02-Map	M-179		Whitmore Spring (historical); B-34-09 23CB			Uinkaret Plateau - South	Mesozoic	Spring					36.33154	-113.23359	No	Grand Canyon Wildlands Council 2002	
573	NURE	CDDC503R					Virgin River Valley	Mesozoic	Spring	CHNL Sh				37.008383093	-113.412784061	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
574	BLM-Legacy	LEG-175		Mokaac Spring; B-40-12 04AE			Virgin River Valley	Mesozoic	Spring					36.89889	-113.58257	Yes	BLM 2010d	Additional Jdrs:4681,4973// Additional Uses:40,12,3,Swnw/40,12,3,Senw/41,12,26,Nenw/41,12,23,Nene
575	BLM-Legacy	LEG-204	1	Lizard Spring West; B-41-12 28BB			Virgin River Valley	Mesozoic	Spring					36.92903	-113.60824	Yes	BLM 2010d	
575	BLM-Legacy	LEG-206	2	Lizard Spring East; B-41-12 28BB			Virgin River Valley	Mesozoic	Spring					36.92903	-113.60824	Yes	BLM 2010d	No Sample Taken/Cement Troughs Still in Existence? Sampled 08-16-89 By Dme. Piped to Tank About 1 Mile to Ne. Seep Has Emerged Between 1985 and 1989 About 60 Feet Sw of De
576	GCWC-02	BLM 147	1	Oak Spring; B-39-12 04AB			Wolf Hole Mnt Vicinity	Mesozoic	Spring	Moenkopi Fm	Ephemeral	Contact		36.81695	-113.58645	Yes	Grand Canyon Wildlands Council 2002	Northwestern Az Strip, East of Wolf Hole Mountain, 1.5 Miles West of Quail Hill
576	BLM-Legacy	LEG-105	2	Oak Spring; B-39-12 04AB			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.81695	-113.58645	Yes	BLM 2010d	
577	BLM-Legacy	LEG-106		Wolf Hole Spring; B-39-12 21BD			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.76805	-113.5939	Yes	BLM 2010d	
578	BLM-Legacy	LEG-103		Tombstone Spring; B-39-12 30BA			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.75694	-113.6282	Yes	BLM 2010d	Dry During Droughty Years.
579	BLM-Legacy	LEG-173		Quail Spring; B-40-12 33AA			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.83186	-113.58275	No	BLM 2010d	Additional Jdrs:4427-Future Plans to Extned Pipeline Thru Sec 16 to Reservoir at Nwnw 15 (to Fill W/ Unused Spring Water)/Pond and Old Wooden Collection Box at Source/Use #2
580	BLM-Legacy	LEG-170		Canyon Spring; B-40-11 17BD			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.86845	-113.50252	Yes	BLM 2010d	
581	BLM-Legacy	LEG-168		Seep Spring; B-40-11 17CA			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.86711	-113.5015	Yes	BLM 2010d	Two Troughs and Overflow Into Dirt Tanks
582	BLM-Legacy	LEG-172		Seegmiller Spring; B-40-11 17DD			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.86141	-113.49514	Yes	BLM 2010d	Large Storage Tank
583	BLM-Legacy	LEG-167		Clay Spring; B-40-11 33DB			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.82417	-113.47859	No	BLM 2010d	Large Storage Tank
584	GCWC-02-Map	M-77		B-40-11 33DA			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.82249	-113.47762	No	Grand Canyon Wildlands Council 2002	
585	BLM-Legacy	LEG-169		Old Canyon Seep; B-40-11 17DB			Wolf Hole Mnt Vicinity	Mesozoic	Spring					36.86989	-113.50353	No	BLM 2010d	
586	NWIS-2	355018111212801		03 098-06.07X11.16			Cameron, AZ	Mesozoic	Well	Shinarump Mbr			188	35.83832927	-111.3584763	Yes	USGS 2010b	
587	NWIS-2	355152111221201		03 098-06.72X09.34			Cameron, AZ	Mesozoic	Well	Shinarump Mbr			40	35.8644399	-111.3706982	Yes	USGS 2010b	
588	NWIS-2	355057111223201		03 098-07.04X10.40			Cameron, AZ	Mesozoic	Well	Holocene Alluvium			54	35.8491624	-111.376254	No	USGS 2010b	
589	NWIS-2	355147111224701		03 098-07.29X09.49			Cameron, AZ	Mesozoic	Well	Holocene Alluvium			50	35.86305104	-111.3804206	No	USGS 2010b	
590	NWIS-2	355627111234101		03 098-08.11X04.09			Cameron, AZ	Mesozoic	Well	Shinarump Mbr			270	35.9408273	-111.3954195	Yes	USGS 2010b	
591	NWIS-2	355342111240401		03 098-08.46X07.21			Cameron, AZ	Mesozoic	Well				50	35.9002725	-111.403198	Yes	USGS 2010b	
592	NWIS-2	355349111240401		03 098-08.50X07.10			Cameron, AZ	Mesozoic	Well	Shinarump Mbr			43	35.89693925	-111.4018092	Yes	USGS 2010b	
593	NWIS-2	355234111243901		03 098-09.04X08.54			Cameron, AZ	Mesozoic	Well	Holocene Alluvium			30	35.8761063	-111.4115318	No	USGS 2010b	
594	NWIS-2	355227111244801		03 098-09.15X08.69			Cameron, AZ	Mesozoic	Well	Moenkopi Fm			370	35.87416189	-111.4140319	Yes	USGS 2010b	
595	NWIS-2	355236111244401		03 098-09.18X08.50			Cameron, AZ	Mesozoic	Well	Holocene Alluvium			45	35.87666184	-111.4129207	No	USGS 2010b	
596	NWIS-2	355236111245001		03 098-09.30X08.52			Cameron, AZ	Mesozoic	Well	Holocene Alluvium			46	35.87666184	-111.4145874	Yes	USGS 2010b	
597	NWIS-2	355125111262801		03 098-10.74X09.85			Cameron, AZ	Mesozoic	Well	Volcanics			92	35.85693998	-111.4418103	Yes	USGS 2010b	
598	NWIS-2	355112111265601		03 098-11.17X10.05			Cameron, AZ	Mesozoic	Well	Moenkopi Fm			155	35.85332894	-111.4495882	Yes	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
599	NWIS-2	355100111270301		03 098-11.23X10.30			Cameron, AZ	Mesozoic	Well				432	35.84999567	-111.4515327	No	USGS 2010b	
600	NWIS-2	355030111274701		03 098-11.95X10.89			Cameron, AZ	Mesozoic	Well	Moenkopi Fm			80	35.8416625	-111.4637552	Yes	USGS 2010b	
601	NWIS-2	355014111295801		03 098-14.01X11.22			Cameron, AZ	Mesozoic	Well				74	35.83721817	-111.5001445	No	USGS 2010b	
602	NWIS-2	354518111215801		A-27-10 06ABC			Cameron, AZ	Mesozoic	Well	Shinarump Mbr			8	35.75499739	-111.366811	Yes	USGS 2010b	
603	NWIS-2	353850111195601		A-26-10 09CAA			Coconino Plateau - East	Mesozoic	Well	Holocene Alluvium				35.6472222	-111.3329238	No	USGS 2010b	
604	NWIS-2	353824111194301		A-26-10 16ABA			Coconino Plateau - East	Mesozoic	Well	Holocene Alluvium			15	35.64000017	-111.3293128	Yes	USGS 2010b	
605	NWIS-2	362525113193801		B-35-10 23AAC			Hurricane Valley	Mesozoic	Well	Holocene Alluvium			25	36.423592	-113.3279969	No	USGS 2010b	
606	NWIS-2	362422113183601		B-35-10 25ADC			Hurricane Valley	Mesozoic	Well				70	36.40609206	-113.3107736	No	USGS 2010b	
607	NWIS-2	363440113191001		B-37-10 25			Hurricane Valley	Mesozoic	Well	Holocene Alluvium			23	36.5777597	-113.3202238	No	USGS 2010b	
608	NWIS-2	363451113200001		B-37-10 26ABD			Hurricane Valley	Mesozoic	Well	Holocene Alluvium				36.5808152	-113.3341132	No	USGS 2010b	
609	NWIS-2	363436113202201		B-37-10 26CAA			Hurricane Valley	Mesozoic	Well	Holocene Alluvium				36.57664847	-113.3402244	No	USGS 2010b	
610	NWIS-2	363900113195601		B-38-10 35ADD			Hurricane Valley	Mesozoic	Well	Moenkopi Fm			90	36.64998258	-113.333004	No	USGS 2010b	
611	NWIS-2	365256113220601		B-40-10 09DAB1			Hurricane Valley	Mesozoic	Well	Holocene Alluvium			28	36.88220555	-113.3691178	No	USGS 2010b	
612	NWIS-2	365256113220501		B-40-10 09DAB2			Hurricane Valley	Mesozoic	Well	Moenkopi Fm			277	36.88220556	-113.36884	No	USGS 2010b	
613	NWIS-2	365432113214201		B-41-10 34D UNSURVEYED			Hurricane Valley	Mesozoic	Well	Holocene Alluvium			22	36.9088723	-113.3624506	No	USGS 2010b	
614	NWIS-2	365915112361001		B-41-03 03A 1 UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Well	Shinarump Mbr			162	36.98748549	-112.603537	Yes[3]	USGS 2010b	
615	NWIS-2	365855112461001		B-41-04 06C UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Well	Navajo Ss				36.98192906	-112.7702075	No	USGS 2010b	
616	NWIS-2	365820112410701		B-41-04 11A UNSURVEYED			Kaibab Paiute Reservation	Mesozoic	Well	Shinarump Mbr			490	36.9722073	-112.6860384	Yes[3]	USGS 2010b	
617	NWIS-2	365540112460501		B-41-04 30CDC			Kaibab Paiute Reservation	Mesozoic	Well	Navajo Ss			309	36.92776275	-112.768817	Yes[3]	USGS 2010b	
618	NWIS-2	363702111271601		01 043-11.37X09.16			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1180	36.6172128	-111.4551512	Yes	USGS 2010b	
619	NWIS-2	364423111232701		01-043-07.80X00.70			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1420	36.73971406	-111.3915396	No	USGS 2010b	
620	NWIS-2	363248111235001		01-043-08.18X14.00			Kaibito Plateau	Mesozoic	Well	Navajo Ss			870	36.54665808	-111.3979267	No	USGS 2010b	
621	NWIS-2	363311111235401		01-043-08.25X13.61			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1116	36.55304696	-111.3990379	No	USGS 2010b	
622	NWIS-2	363916111243701		01-043-08.90X06.60			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1268	36.6544358	-111.4109838	No	USGS 2010b	
623	NWIS-2	363215111253601		01-043-09.82X14.66			Kaibito Plateau	Mesozoic	Well	Navajo Ss			585	36.5374909	-111.4273718	Yes	USGS 2010b	
624	NWIS-2	363705111265201		01-043-10.98X09.10			Kaibito Plateau	Mesozoic	Well				602	36.61804628	-111.4484844	No	USGS 2010b	
625	NWIS-2	363708111271301		01-043-11.30X09.05			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1220	36.6188795	-111.4543179	No	USGS 2010b	
626	NWIS-2	363204111300801		01-044-00.10X14.85			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1200	36.5344341	-111.502929	No	USGS 2010b	
627	NWIS-2	363537111301801		01-044-00.30X10.80			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1200	36.59360088	-111.5057078	Yes	USGS 2010b	
628	NWIS-2	363810111314201		01-044-01.53X07.84			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1500	36.63610066	-111.5290427	Yes	USGS 2010b	
629	NWIS-2	363805111315301		01-044-01.75X07.95			Kaibito Plateau	Mesozoic	Well	Navajo Ss			820	36.6347117	-111.5320984	No	USGS 2010b	
630	NWIS-2	363808111315301		01-044-01.78X07.89			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1397	36.63554507	-111.5320984	No	USGS 2010b	
631	NWIS-2	363815111355001		01-044-05.40X07.73			Kaibito Plateau	Mesozoic	Well	Navajo Ss			1280	36.63748868	-111.5979345	No	USGS 2010b	
632	NWIS-2	362643111184701		01-060-03.49X03.78			Kaibito Plateau	Mesozoic	Well	Navajo Ss			740	36.4452701	-111.3137569	Yes	USGS 2010b	
633	NWIS-2	362824111245301		01-060-09.15X01.85			Kaibito Plateau	Mesozoic	Well	Navajo Ss			356	36.4733242	-111.4154262	Yes	USGS 2010b	
634	NWIS-2	362339111250201		01-060-09.31X07.30			Kaibito Plateau	Mesozoic	Well	Navajo Ss			430	36.394157	-111.4179249	Yes	USGS 2010b	
635	NWIS-2	362722111291201		01-060-13.17X03.04			Kaibito Plateau	Mesozoic	Well	Navajo Ss			996	36.4561007	-111.4873719	No	USGS 2010b	
636	NWIS-2	362723111294601		01-060-13.70X03.00			Kaibito Plateau	Mesozoic	Well	Navajo Ss			180	36.45637835	-111.4968165	No	USGS 2010b	
637	NWIS-2	363817111375001		03 044-07.23X07.69			Kaibito Plateau	Mesozoic	Well	Moenkopi Fm			100	36.6380438	-111.6312692	No	USGS 2010b	
638	NWIS-2	363825111380001		03 044-07.35X07.55			Kaibito Plateau	Mesozoic	Well				180	36.640266	-111.634047	No	USGS 2010b	
639	NWIS-2	361856111245601		03 060-09.22X12.71			Kaibito Plateau	Mesozoic	Well	Navajo Ss			467	36.3155454	-111.4162569	Yes	USGS 2010b	
640	NWIS-2	362326111303001		03 061-00.48X07.58			Kaibito Plateau	Mesozoic	Well	Moenkopi Fm			125	36.3905445	-111.509038	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
641	NWIS-2	362343111305001		03 061-00.80X07.22			Kaibito Plateau	Mesozoic	Well	Moenkopi Fm			180	36.3952667	-111.5145939	No	USGS 2010b	
642	NWIS-2	361406111195201		03 078-04.52X01.04			Kaibito Plateau	Mesozoic	Well	Navajo Ss			155	36.2349908	-111.3318095	No	USGS 2010b	
643	NWIS-2	361410111194001		A-33-10 21BB			Kaibito Plateau	Mesozoic	Well				155	36.23610195	-111.328476	No	USGS 2010b	
644	NWIS-2	365841111314801		A-41-08 04DDA1			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss				36.97804266	-111.5307165	No	USGS 2010b	
645	NWIS-2	370438111395001		D-43-02 14BAB1			Lake Powell Vicinity	Mesozoic	Well				537	37.0772078	-111.6646112	No	USGS 2010b	
646	NWIS-2	370010111302501		D-44-04 07AAB1			Lake Powell Vicinity	Mesozoic	Well				800	37.00276485	-111.5076608	No	USGS 2010b	
647	NWIS-2	370006111300401		D-44-04 08BAC1			Lake Powell Vicinity	Mesozoic	Well	Glen Canyon Grp				37.0016538	-111.5018272	No	USGS 2010b	
648	NWIS-2	365553111243001		01 028-08.79X04.72			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			350	36.93137826	-111.4090443	No	USGS 2010b	
649	NWIS-2	365704111250201		01 028-09.29X03.36			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			450	36.9511001	-111.417934	No	USGS 2010b	
650	NWIS-2	365631111281701		01 028-12.31X03.98			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			560	36.9419327	-111.4721025	No	USGS 2010b	
651	NWIS-2	364858111201701		01-028-04.93X12.74			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1417	36.81610298	-111.3387616	Yes	USGS 2010b	
652	NWIS-2	365307111212301		01-028-05.90X07.90			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1540	36.8852685	-111.357097	Yes	USGS 2010b	
653	NWIS-2	365125111263401		01-028-10.70X09.80			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1500	36.85693419	-111.4434883	No	USGS 2010b	
654	NWIS-2	365125111302301		01-029-00.45X09.86			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1406	36.8569332	-111.5071017	No	USGS 2010b	
655	NWIS-2	364900111305401		01-029-00.80X12.58			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1402	36.8166558	-111.5157121	No	USGS 2010b	
656	NWIS-2	365844111314501		A-41-08 04DDA			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			925	36.97887599	-111.5298832	Yes	USGS 2010b	
657	NWIS-2	365723111302801		A-41-08 14BCA			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1200	36.95637647	-111.508493	Yes	USGS 2010b	
658	NWIS-2	365726111303201		A-41-08 14BCB			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1500	36.95720979	-111.5096042	Yes	USGS 2010b	
659	NWIS-2	365611111294301		A-41-08 23DAC			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			910	36.93637687	-111.495992	Yes	USGS 2010b	
660	NWIS-2	365557111295701		A-41-08 23DCD			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			1285	36.93248797	-111.499881	Yes	USGS 2010b	
661	NWIS-2	365930111332401		A-42-08 32CDD			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			935	36.99165335	-111.5573844	No	USGS 2010b	
662	NWIS-2	365952111294701		A-42-08 35DAB1			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			603	36.997765	-111.4971048	Yes	USGS 2010b	
663	NWIS-2	365947111294901		A-42-08 35DAB2			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			620	36.9963761	-111.4976603	Yes	USGS 2010b	
664	NWIS-2	365945111293601		A-42-08 35DAD			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			625	36.9958206	-111.494049	Yes	USGS 2010b	
665	NWIS-2	365928111295001		A-42-08 35DCD			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			800	36.9910984	-111.497938	Yes	USGS 2010b	
666	NWIS-2	365942111292501		A-42-08 36CBC			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss				36.99498735	-111.4909934	Yes	USGS 2010b	
667	NWIS-2	365929111293201		A-42-08 36CCC1			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			625	36.99137626	-111.4929378	Yes	USGS 2010b	
668	NWIS-2	365930111292501		A-42-08 36CCC2			Lake Powell Vicinity	Mesozoic	Well	Navajo Ss			703	36.99165406	-111.4909933	Yes	USGS 2010b	
669	NWIS-2	365956112514101		B-42-05 32B UNSURVEYED			Moccasin Mtns	Mesozoic	Well	Navajo Ss			250	36.99887327	-112.8621555	No	USGS 2010b	
670	NURE	CDDE502R					Moccasin Mtns	Mesozoic	Well	NVJF Ss				37.016984102	-112.967270302	Yes	USGS 2009b	
671	NURE	GCAE504R					Moccasin Mtns	Mesozoic	Well	TRSS				36.99768439	-112.863966619	Yes	USGS 2009b	
672	NURE	GCAE505R					Moccasin Mtns	Mesozoic	Well	TRSS Ss				36.94858469	-112.863565496	Yes	USGS 2009b	
673	NWIS-2	361833111275301		03 060-11.97X13.15			Painted Desert	Mesozoic	Well	Shinarump Mbr			100	36.30915574	-111.4654244	Yes	USGS 2010b	
674	NWIS-2	360407111231401		03 078-07.66X12.47			Painted Desert	Mesozoic	Well	Shinarump Mbr			166	36.0686032	-111.3879194	Yes	USGS 2010b	
675	NWIS-2	360127111235901		03 078-08.37X15.55			Painted Desert	Mesozoic	Well	Chinle Fm			166	36.0241592	-111.4004189	Yes	USGS 2010b	
676	NWIS-2	360002111245801		03 078-09.30X17.18			Painted Desert	Mesozoic	Well	Chinle Fm			105	36.00054827	-111.4168077	Yes	USGS 2010b	
677	NWIS-2	360742111265301		03 078-11.10X08.40			Painted Desert	Mesozoic	Well	Shinarump Mbr			245	36.128324	-111.4487545	No	USGS 2010b	
678	NWIS-2	360237111270001		03 078-11.21X14.22			Painted Desert	Mesozoic	Well	Chinle Fm			317	36.04360296	-111.4506977	No	USGS 2010b	
679	NWIS-2	365325111532701		A-40-05 05CCC			Paria Plateau	Mesozoic	Well	Moenave Fm			1340	36.8902637	-111.8915616	No	USGS 2010b	
680	NWIS-2	365237111481901		A-40-05 12DDB			Paria Plateau	Mesozoic	Well	Moenave Fm			1468	36.87693025	-111.8060022	Yes	USGS 2010b	
681	NWIS-2	364910111522701		A-40-05 33CBC			Paria Plateau	Mesozoic	Well	Navajo Ss			1175	36.81943105	-111.8748928	Yes	USGS 2010b	
682	NWIS-2	365325111445201		A-40-06 03CCC			Paria Plateau	Mesozoic	Well	Moenave Fm			1802	36.8902633	-111.7485	No	USGS 2010b	
683	NWIS-2	365716111560601		A-41-04 14CBB			Paria Plateau	Mesozoic	Well	Moenave Fm			600	36.9544298	-111.9357314	No	USGS 2010b	
684	NWIS-2	365716111581601		A-41-04 16CBB			Paria Plateau	Mesozoic	Well	Moenave Fm			700	36.95442989	-111.9718441	No	USGS 2010b	
685	NWIS-2	361128113304201	1	B-32-11 07BAC			Shivwits Plateau	Mesozoic	Well	Moenkopi Fm			27	36.19109274	-113.512437	No	USGS 2010b	
685	NURE	GCDB502R	2				Shivwits Plateau	Mesozoic	Well	KBBL Carbonate				36.190381639	-113.512170353	Yes	USGS 2009b	
686	NWIS-2	360905113320401	1	B-32-12 23DDD			Shivwits Plateau	Mesozoic	Well				66	36.1513718	-113.5352159	No	USGS 2010b	
686	NURE	GCDB501R	2				Shivwits Plateau	Mesozoic	Well	QTRN Volcanics - Mafic				36.151182934	-113.535571447	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
687	NWIS-2	360938113312001		B-32-12 24ACA			Shivwits Plateau	Mesozoic	Well	Moenkopi Fm			23	36.16053809	-113.522993	No	USGS 2010b	
688	NWIS-2	360840113314001		B-32-12 25BDC			Shivwits Plateau	Mesozoic	Well				65	36.14442744	-113.5285489	No	USGS 2010b	
689	NWIS-2	360819113342701		B-32-12 28DDB			Shivwits Plateau	Mesozoic	Well	Holocene Alluvium			23	36.13859487	-113.57494	No	USGS 2010b	
690	NWIS-2	361401113334001		B-33-12 27ADB			Shivwits Plateau	Mesozoic	Well	Holocene Alluvium			25	36.23359256	-113.5618839	Yes	USGS 2010b	
691	NWIS-2	370238113051201		C-43-11 15CBC1			Uinkaret Plateau - North	Mesozoic	Well				167	37.04387277	-113.0874415	No	USGS 2010b	
692	NWIS-2	365120113132701		B-40-09 23ADA1			Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm				36.85554	-113.2249464	No	USGS 2010b	
693	NWIS-2	365120113132702		B-40-09 23ADA2			Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			130	36.85554	-113.2249464	No	USGS 2010b	
694	NWIS-2	365704112523801		B-41-05 18CAC			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.95109576	-112.8779883	No	USGS 2010b	
695	NWIS-2	365650112523101		B-41-05 18CDD			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.9472069	-112.8760437	No	USGS 2010b	
696	NWIS-2	365920112582501		B-41-06 06AAA1			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			37	36.98887319	-112.9743812	No	USGS 2010b	
697	NWIS-2	365920112582502		B-41-06 06AAA2			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			72	36.98887319	-112.9743812	No	USGS 2010b	
698	NWIS-2	365920112582503		B-41-06 06AAA3			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			23.5	36.98887319	-112.9743812	No	USGS 2010b	
699	NWIS-2	365915112582501		B-41-06 06AAD			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			110	36.9874843	-112.9743812	No	USGS 2010b	
700	NWIS-2	365917112590001		B-41-06 06BAA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			105	36.98803985	-112.9841038	Yes	USGS 2010b	
701	NWIS-2	365914112590001		B-41-06 06BAD			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			98	36.9872065	-112.9841038	Yes	USGS 2010b	
702	NWIS-2	365855112590401		B-41-06 06CAA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.98192877	-112.9852148	No	USGS 2010b	
703	NWIS-2	365759112550401		B-41-06 11CBB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.96637339	-112.9185456	No	USGS 2010b	
704	NWIS-2	365653112544001		B-41-06 14CDD			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.94804018	-112.9118783	No	USGS 2010b	
705	NWIS-2	365650112541401		B-41-06 14DDC			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.94720686	-112.9046558	No	USGS 2010b	
706	NWIS-2	365650112561501		B-41-06 16DDD			Uinkaret Plateau - North	Mesozoic	Well				635	36.9472068	-112.9382682	No	USGS 2010b	
707	NWIS-2	365650112592501		B-41-06 18CCC			Uinkaret Plateau - North	Mesozoic	Well				200	36.9472067	-112.9910478	No	USGS 2010b	
708	NWIS-2	365622112582201		B-41-06 20BCC			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			60	36.939429	-112.973547	No	USGS 2010b	
709	NWIS-2	365618112575001		B-41-06 20CAA			Uinkaret Plateau - North	Mesozoic	Well				33.5	36.9383179	-112.9646579	No	USGS 2010b	
710	NWIS-2	365617112581501		B-41-06 20CBB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			63	36.93804014	-112.9716026	No	USGS 2010b	
711	NWIS-2	365609112560701		B-41-06 22CBC			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			105	36.93581799	-112.9360457	Yes	USGS 2010b	
712	NWIS-2	365558112551701		B-41-06 22DDC			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			30	36.93276247	-112.9221562	No	USGS 2010b	
713	NWIS-2	365602112543701		B-41-06 23CDA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			40	36.93387359	-112.9110447	No	USGS 2010b	
714	NWIS-2	365610112541201		B-41-06 23DAC			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			95	36.9360958	-112.9041	No	USGS 2010b	
715	NWIS-2	365610112542601		B-41-06 23DBD1			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			40	36.9360958	-112.907989	No	USGS 2010b	
716	NWIS-2	365611112542301		B-41-06 23DBD2			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			35	36.93637358	-112.9071557	No	USGS 2010b	
717	NWIS-2	365605112541501		B-41-06 23DDB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			85	36.9347069	-112.9049334	No	USGS 2010b	
718	NWIS-2	365642112531201		B-41-06 24AAB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			72	36.94498468	-112.8874329	Yes	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
719	NWIS-2	365640112534301		B-41-06 24BAC			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.9444291	-112.8960444	No	USGS 2010b	
720	NWIS-2	365635112533601		B-41-06 24BAD1			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.9430402	-112.8940998	No	USGS 2010b	
721	NWIS-2	365635112533602		B-41-06 24BAD2			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.9430402	-112.8940998	No	USGS 2010b	
722	NWIS-2	365525112560501		B-41-06 27CBA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			65	36.9235958	-112.9354899	Yes	USGS 2010b	
723	NWIS-2	365524112560801		B-41-06 27CBB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			65	36.92331806	-112.9363232	No	USGS 2010b	
724	NWIS-2	365550112562201		B-41-06 28AAB1			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			61	36.9305402	-112.9402124	No	USGS 2010b	
725	NWIS-2	365549112562301		B-41-06 28AAB2			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			65	36.93026245	-112.9404902	No	USGS 2010b	
726	NWIS-2	365541112561601		B-41-06 28ADA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			68	36.92804025	-112.9385456	No	USGS 2010b	
727	NWIS-2	365553112570701		B-41-06 28BBA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.93137354	-112.9527129	No	USGS 2010b	
728	NWIS-2	365553112575001		B-41-06 29ABB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.9313735	-112.9646577	No	USGS 2010b	
729	NWIS-2	365539112571901		B-41-06 29ADA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.92748467	-112.9560463	No	USGS 2010b	
730	NWIS-2	365532112571901		B-41-06 29ADD			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			65	36.9255402	-112.9560462	Yes	USGS 2010b	
731	NWIS-2	365911112594701		B-41-07 01ABD			Uinkaret Plateau - North	Mesozoic	Well	Shinarump Mbr			450	36.98637317	-112.9971597	No	USGS 2010b	
732	NWIS-2	365648113003901	1	B-41-07 23AAA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.94665115	-113.0116042	No	USGS 2010b	
732	NURE	GCAD501R	2				Uinkaret Plateau - North	Mesozoic	Well	TRSS Ss				36.946484486	-113.012170886	Yes	USGS 2009b	
733	NWIS-2	365636113003701		B-41-07 23ADA			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			65	36.9433178	-113.0110486	Yes	USGS 2010b	
734	NWIS-2	365643112593001		B-41-07 24AAA			Uinkaret Plateau - North	Mesozoic	Well	Shinarump Mbr			212	36.94526229	-112.9924368	No	USGS 2010b	
735	NWIS-2	365645113001501		B-41-07 24BAB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium				36.9458178	-113.0049372	No	USGS 2010b	
736	NWIS-2	365504113110001		B-41-08 32BAB			Uinkaret Plateau - North	Mesozoic	Well	Moenkopi Fm			35	36.9177622	-113.1841113	No	USGS 2010b	
737	NWIS-2	365931112592301		B-42-06 31CCC			Uinkaret Plateau - North	Mesozoic	Well				585	36.9919287	-112.9904929	Yes	USGS 2010b	
738	NWIS-2	365929112582701		B-42-06 31DDD			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			105	36.99137317	-112.9749368	No	USGS 2010b	
739	NWIS-2	370001112575901		B-42-06 32BDB			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			84	37.000262	-112.9671589	No	USGS 2010b	
740	NWIS-2	365929112580801		B-42-06 32CCD			Uinkaret Plateau - North	Mesozoic	Well	Holocene Alluvium			104	36.99137318	-112.9696589	No	USGS 2010b	
741	NURE	CDDD502R					Uinkaret Plateau - North	Mesozoic	Well	QTRN				37.000584288	-113.180278037	Yes	USGS 2009b	
742	NURE	GCAC502R					Uinkaret Plateau - North	Mesozoic	Well	QTRN Other				36.907783501	-113.352883728	Yes	USGS 2009b	
743	NURE	GCAD502R					Uinkaret Plateau - North	Mesozoic	Well	TRSS Ss				36.959584381	-113.150176698	Yes	USGS 2009b	
744	NURE	GCAD507R					Uinkaret Plateau - North	Mesozoic	Well	TRSS Volcanics - Mafic				36.919384449	-113.183977981	Yes	USGS 2009b	
745	NURE	GCAD508R					Uinkaret Plateau - North	Mesozoic	Well	TRSS Carbonate				36.939784367	-113.249380784	Yes	USGS 2009b	
746	NURE	GCAD509R					Uinkaret Plateau - North	Mesozoic	Well	TRSS Carbonate				36.866384467	-113.225079774	Yes	USGS 2009b	
747	NURE	GCAD514R					Uinkaret Plateau - North	Mesozoic	Well	TRSS				36.997284304	-113.195178601	Yes	USGS 2009b	
748	NURE	GCAE506R					Uinkaret Plateau - North	Mesozoic	Well	TRSS				36.94948464	-112.892966574	Yes	USGS 2009b	
749	NURE	GCAE507R					Uinkaret Plateau - North	Mesozoic	Well	TRSS Carbonate				36.938284595	-112.963468928	Yes	USGS 2009b	
750	NWIS-2	362331113114501		B-35-08 31BCD			Uinkaret Plateau - South	Mesozoic	Well	Moenkopi Fm			600	36.39192567	-113.1966027	No	USGS 2010b	
751	NWIS-2	362405113131501		B-35-09 26DAC			Uinkaret Plateau - South	Mesozoic	Well	Moenkopi Fm			670	36.40137009	-113.2216042	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
752	NWIS-2	370418112380801		C-43-07 16DBB1			Vermilion Cliffs (UT)	Mesozoic	Well	Navajo Ss			159	37.07165147	-112.6363174	Yes	USGS 2010b	
753	NWIS-2	370450113345001		C-42-15 31CCD1			Virgin River Valley	Mesozoic	Well				100	37.08053658	-113.5813454	No	USGS 2010b	
754	NWIS-2	370455113332401		C-42-15 32DCC1			Virgin River Valley	Mesozoic	Well				72	37.08192577	-113.5574554	No	USGS 2010b	
755	NWIS-2	370500113315102		C-42-15 33DDB1			Virgin River Valley	Mesozoic	Well				70	37.08331499	-113.5316209	No	USGS 2010b	
756	NWIS-2	370500113315101		C-42-15 33DDD1			Virgin River Valley	Mesozoic	Well				45	37.08331499	-113.5316209	No	USGS 2010b	
757	NWIS-2	370436113201501		C-43-13 05BDD1			Virgin River Valley	Mesozoic	Well				530	37.07664987	-113.3382827	No	USGS 2010b	
758	NWIS-2	370140113192801		C-43-13 21CCA1			Virgin River Valley	Mesozoic	Well	Moenave Fm			185	37.02776138	-113.3252267	No	USGS 2010b	
759	NWIS-2	370220113263001		C-43-14 20ABB1			Virgin River Valley	Mesozoic	Well				260	37.03887159	-113.4424514	No	USGS 2010b	
760	NWIS-2	370037113281401		C-43-14 31BAB1			Virgin River Valley	Mesozoic	Well	Alluvium			200	37.0102604	-113.4713408	No	USGS 2010b	
761	NWIS-2	370000113273301		C-43-14 31DDD1			Virgin River Valley	Mesozoic	Well				14	36.9999828	-113.4599517	No	USGS 2010b	
762	NWIS-2	370453113294301		C-43-15 02AAA1			Virgin River Valley	Mesozoic	Well				160	37.08137098	-113.4960638	Yes	USGS 2010b	
763	NWIS-2	370458113300701		C-43-15 02ABB1			Virgin River Valley	Mesozoic	Well				100	37.0827598	-113.5027307	No	USGS 2010b	
764	NWIS-2	370426113291201		C-43-15 02DAA1			Virgin River Valley	Mesozoic	Well				150	37.07387108	-113.4874525	No	USGS 2010b	
765	NWIS-2	370412113320301		C-43-15 04DAC1			Virgin River Valley	Mesozoic	Well				190	37.06998167	-113.5349543	No	USGS 2010b	
766	NWIS-2	370417113331601		C-43-15 05DBD1			Virgin River Valley	Mesozoic	Well				153	37.07137029	-113.555233	No	USGS 2010b	
767	NWIS-2	370450113345002		C-43-15 06BBA1			Virgin River Valley	Mesozoic	Well				85	37.08053658	-113.5813454	No	USGS 2010b	
768	NWIS-2	370346113315501		C-43-15 09ADA1			Virgin River Valley	Mesozoic	Well				145	37.0627595	-113.532732	No	USGS 2010b	
769	NWIS-2	370333113323901		C-43-15 09CBA1			Virgin River Valley	Mesozoic	Well				125	37.05914826	-113.5449547	No	USGS 2010b	
770	NWIS-2	370322113324601		C-43-15 09CBB1			Virgin River Valley	Mesozoic	Well				200	37.05609269	-113.5468993	No	USGS 2010b	
771	NWIS-2	370304113315501		C-43-15 09DDD1			Virgin River Valley	Mesozoic	Well				125	37.0510929	-113.5327319	No	USGS 2010b	
772	NWIS-2	370345113310201		C-43-15 10ACA1			Virgin River Valley	Mesozoic	Well				300	37.0624819	-113.518009	No	USGS 2010b	
773	NWIS-2	370342113311201		C-43-15 10ACB1			Virgin River Valley	Mesozoic	Well				75	37.06164857	-113.520787	No	USGS 2010b	
774	NWIS-2	370338113311601		C-43-15 10ACC1			Virgin River Valley	Mesozoic	Well				100	37.06053745	-113.5218981	Yes	USGS 2010b	
775	NWIS-2	370309113313601		C-43-15 10CCD1			Virgin River Valley	Mesozoic	Well				130	37.05248186	-113.5274539	No	USGS 2010b	
776	NWIS-2	370239113311301		C-43-15 10DBB1			Virgin River Valley	Mesozoic	Well				125	37.04414865	-113.5210647	No	USGS 2010b	
777	NWIS-2	370350113291201		C-43-15 12BDD1			Virgin River Valley	Mesozoic	Well				497	37.06387114	-113.4874525	No	USGS 2010b	
778	NWIS-2	370308113293501		C-43-15 12CCC1			Virgin River Valley	Mesozoic	Well				407	37.05220449	-113.4938414	No	USGS 2010b	
779	NWIS-2	370308113292202		C-43-15 12CCD1			Virgin River Valley	Mesozoic	Well				229	37.0522045	-113.4902303	No	USGS 2010b	
780	NWIS-2	370308113292201		C-43-15 12CCD2			Virgin River Valley	Mesozoic	Well				172	37.0522045	-113.4902303	Yes	USGS 2010b	
781	NWIS-2	370310113293001		C-43-15 12CDD1			Virgin River Valley	Mesozoic	Well				172	37.05276005	-113.4924525	Yes	USGS 2010b	
782	NWIS-2	370255113315001		C-43-15 16AAD1			Virgin River Valley	Mesozoic	Well				195	37.0485929	-113.531343	No	USGS 2010b	
783	NWIS-2	370246113315201		C-43-15 16ADD1			Virgin River Valley	Mesozoic	Well				200	37.04609294	-113.5318985	No	USGS 2010b	
784	NWIS-2	370240113323501		C-43-15 16CAB1			Virgin River Valley	Mesozoic	Well				264	37.0444261	-113.5438435	No	USGS 2010b	
785	NWIS-2	370231113320301		C-43-15 16DAC1			Virgin River Valley	Mesozoic	Well				150	37.04192625	-113.5349542	No	USGS 2010b	
786	NWIS-2	370230113322001		C-43-15 16DBC1			Virgin River Valley	Mesozoic	Well				105	37.0416484	-113.5396767	No	USGS 2010b	
787	NWIS-2	370230113321001		C-43-15 16DBC2			Virgin River Valley	Mesozoic	Well				158	37.04164845	-113.5368987	No	USGS 2010b	
788	NWIS-2	370230113321801		C-43-15 16DCC1			Virgin River Valley	Mesozoic	Well				160	37.0416484	-113.539121	No	USGS 2010b	
789	NWIS-2	370200113303501		C-43-15 23BCA1			Virgin River Valley	Mesozoic	Well				370	37.0333155	-113.5105086	No	USGS 2010b	
790	NWIS-2	370204113310701		C-43-15 23BCB1			Virgin River Valley	Mesozoic	Well				400	37.0344265	-113.5193979	No	USGS 2010b	
791	NWIS-2	370034113290801		C-43-15 25CDD1			Virgin River Valley	Mesozoic	Well				384	37.009427	-113.4863411	Yes	USGS 2010b	
792	NWIS-2	370045113284201		C-43-15 25DDD1			Virgin River Valley	Mesozoic	Well				144	37.01248259	-113.4791188	Yes	USGS 2010b	
793	NWIS-2	370353113345001		C-43-16 12AAA1			Virgin River Valley	Mesozoic	Well				50	37.0647033	-113.5813453	Yes	USGS 2010b	
794	NWIS-2	365951113343201		B-42-12 34ADD			Virgin River Valley	Mesozoic	Well	Holocene Alluvium			25	36.9974814	-113.5763449	No	USGS 2010b	
795	NURE	23077					Coconino Plateau - East	Perched	Spring					35.950185077	-112.524236512	Yes	USGS 2009b	
796	NWIS-2	355032113064701	1	Upper Pine Spring; B-28-08 32ADA			Coconino Plateau - West	Perched	Spring	Quaternary Alluvium				35.8422095	-113.1138136	No	USGS 2010b	
796	Wenrich-94	10A-W82	2	Upper Pine Spring			Coconino Plateau - West	Perched	Spring	Kaibab Ls				35.841931713	-113.114091323	Yes	Wenrich et al. 1994	
797	Wenrich-94	34A+B-W82	1	Hockey Puck Spring; B-30-08 31DCD			Coconino Plateau - West	Perched	Spring	Hermit Sh - Coconino Ss		Contact		35.933596715	-113.176038225	Yes	Wenrich et al. 1994	
797	NWIS-2	355602113103200	2	B-30-08 31DCD			Coconino Plateau - West	Perched	Spring	Coconino Ss				35.9338745	-113.176316	No	USGS 2010b	
797	NURE	23021	3				Coconino Plateau - West	Perched	Spring					35.933885613	-113.17676045	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
798	NWIS-2	355959113122700	1	Big Spring; B-30-09 11 UNSURVEYED			Coconino Plateau - West	Perched	Spring	Toroweap Fm				35.99970668	-113.2082618	Yes	USGS 2010b	
798	Wenrich-94	37A-W82	2	Big Spring			Coconino Plateau - West	Perched	Spring	Coconino Ss				35.999706654	-113.207428431	Yes	Wenrich et al. 1994	
799	NWIS-2	360435113104700	1	Beecher Spring; B-31-08 18BAD			Coconino Plateau - West	Perched	Spring	Hermit Sh				36.0763721	-113.1804841	Yes	USGS 2010b	
799	Wenrich-94	30A+B-W82	2	Beecher Spring			Coconino Plateau - West	Perched	Spring	Hermit Sh - Esplanade Ss		Contact		36.076094311	-113.17881745	Yes	Wenrich et al. 1994	
800	GWSI-1	355013113055201	1	Pine Springs; B-28-08 02DDB			Coconino Plateau - West	Perched	Spring					35.836931375	-113.098535487	Yes	ADWR 2009b	
800	Wenrich-94	12A-W82	2	Pine Spring; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Spring	Tertiary gravel				35.83665408	-113.098535287	Yes	Wenrich et al. 1994	
801	Wenrich-94	15A-W82	1	Pocomate Springs			Coconino Plateau - West	Perched	Spring	Coconino Ss				35.82193229	-113.161592833	Yes	Wenrich et al. 1994	
801	NURE	23172	2				Coconino Plateau - West	Perched	Spring					35.82238788	-113.161559533	Yes	USGS 2009b	
802	Wenrich-94	11A-W82		Unnamed spring 1/3 mi from Pine Tank			Coconino Plateau - West	Perched	Spring	Kaibab Ls				35.839709529	-113.103813273	Yes	Wenrich et al. 1994	
803	Wenrich-94	35A-W82		Red Spring			Coconino Plateau - West	Perched	Spring	Coconino Ss				36.070538166	-113.023811786	Yes	Wenrich et al. 1994	
804	Wenrich-94	36A-W82		Moss Spring			Coconino Plateau - West	Perched	Spring	Coconino Ss				36.061649367	-113.027700641	Yes	Wenrich et al. 1994	
805	Wenrich-94	8A-W82		Pocomate Springs			Coconino Plateau - West	Perched	Spring	Coconino Ss				35.823598952	-113.160481702	Yes	Wenrich et al. 1994	
806	NWIS-2	360744112595101		B-32-07 26DBA			Grand Canyon - Central	Perched	Spring	Supai Fm				36.12887086	-112.9982558	Yes	USGS 2010b	
807	NWIS-2	360733113035800	1	Cement Tank Spring; B-32-07 30DAD			Grand Canyon - Central	Perched	Spring	Supai Fm				36.1258155	-113.0668694	Yes	USGS 2010b	
807	NURE	GCDD501R	2				Grand Canyon - Central	Perched	Spring	CCNN Ss (perched)				36.125982185	-113.06725835	Yes	USGS 2009b	
808	GWSI-1	361345113031701	1	Saddle Horse Spring; B-33-07 28C			Grand Canyon - Central	Perched	Spring	Supai Fm	Perennial	Contact		36.2291481	-113.05548098	Yes	ADWR 2009b	
808	NWIS-2	361345113031701	2	B-33-07 28C UNSURVEYED			Grand Canyon - Central	Perched	Spring	Supai Fm				36.22914777	-113.0554812	Yes	USGS 2010b	
808	NWIS-1	361344113032001	3	Saddle Horse Spring			Grand Canyon - Central	Perched	Spring					36.22888889	-113.05555556	Yes	USGS 2009a	
808	GCWC-02	GCNP-1	4	Saddle Horse Spring (South); B-33-07 28CB			Grand Canyon - Central	Perched	Spring	Esplanade Ss	Perennial	Contact		36.22867	-113.05551	Yes	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau Area, One Mile North of Toroweap Overlook in Saddle Horse Canyon
809	NWIS-2	361237113025700		Honga Above the Mouth; B-33-07 33 UNSURVEYED			Grand Canyon - Central	Perched	Spring	Supai Fm				36.21025907	-113.0499252	Yes	USGS 2010b	
810	Wenrich-94	29A-W82		Hells Hollow Spring			Grand Canyon - Central	Perched	Spring	Esplanade Ss				36.144982092	-113.109926891	Yes	Wenrich et al. 1994	
811	Wenrich-94	49A-W82		Horsehair Spring			Grand Canyon - Central	Perched	Spring	Wescogame Fm				36.156926608	-112.915753276	Yes	Wenrich et al. 1994	
812	GCWC-02	GCNP-2		Saddle Horse Spring (North); B-33-07 28BC			Grand Canyon - Central	Perched	Spring	Esplanade Ss	Ephemeral	Fracture		36.23439	-113.05682	Yes	Grand Canyon Wildlands Council 2002	West Central Az Strip, Uinkaret Plateau Area, 1.25 Miles North of Toroweap Overlook in Saddle Horse Canyon
813	GCWC-02-Map	M-307		Jewell Spring; B-35-04 36A			Grand Canyon - Central	Perched	Spring					36.39354	-112.66522	No	Grand Canyon Wildlands Council 2002	
814	GCWC-02-Map	M-10		Cork Spring; B-34-05 26AD			Grand Canyon - Central	Perched	Spring					36.32014	-112.7912	No	Grand Canyon Wildlands Council 2002	
815	GWSI-1	361221112034001	1	Cliff Dweller Spring; A-32-03 03A			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls	Perennial			36.205815586	-112.061835595	Yes	ADWR 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
815	NWIS-2	361221112034001	2	A-32-03 03A UNSURVEYED			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls				36.2058159	-112.0618357	No	USGS 2010b	
815	GCNP-1	TRAN003	3	Cliff Dweller Spring			Grand Canyon - North Rim	Perched	Spring	Kaibab LS/ Toroweap				36.205815586	-112.061835595	Yes	Grand Canyon National Park 2010a	
815	GCWC-02-Map	M-213	4	Cliff Dweller Spring; A-32.5-03 34			Grand Canyon - North Rim	Perched	Spring					36.20566	-112.06155	No	Grand Canyon Wildlands Council 2002	
816	GWSI-1	361302112040501	1	Sprayfield Spring; A-33-03 34B			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls				36.217204457	-112.06878091	Yes	ADWR 2009b	
816	NWIS-2	361302112040501	2	A-33-03 34B UNSURVEYED			Grand Canyon - North Rim	Perched	Spring	Kaibab Ls				36.21720468	-112.0687805	No	USGS 2010b	
817	GCWC-02	GCNP-18	1	South Big Spring; A-34-01 26AC			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Perennial	Contact		36.31821	-112.26083	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of Big Springs Canyon Near Lancelot Point, this is The Down Canyon Spring
817	GWSI-1	361906112153701	2	South Big Spring; A-34-01 26A			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm				36.318314241	-112.26100856	Yes	ADWR 2009b	
817	NWIS-2	361906112153701	3	A-34-01 26A UNSURVEYED			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm				36.31831457	-112.2610083	No	USGS 2010b	
818	GCNP-1	BRIG009	1	Greenland Spring; A-33-04 19AD			Grand Canyon - North Rim	Perched	Spring	Coconino SS				36.244275727	-112.001766903	Yes	Grand Canyon National Park 2010a	
818	GCWC-02-Map	M-233	2	Greenland Spring; A-33-04 19AD			Grand Canyon - North Rim	Perched	Spring					36.24426	-112.00156	No	Grand Canyon Wildlands Council 2002	
819	GCWC-02-Map	M-211	1	Cliff Spring; A-32-04 27			Grand Canyon - North Rim	Perched	Spring					36.12441	-111.95312	No	Grand Canyon Wildlands Council 2002	
819	GCNP-1	CLIF001	2	Cliff Spring			Grand Canyon - North Rim	Perched	Spring	Kaibab/ Toroweap contact				36.125120798	-111.954345074	Yes	Grand Canyon National Park 2010a	
820	GCWC-02-Map	M-230	1	Bright Angel Spring; A-33-03 34BA			Grand Canyon - North Rim	Perched	Spring					36.2203	-112.06774	No	Grand Canyon Wildlands Council 2002	
820	GCNP-1	TRAN002	2	Bright Angel Spring			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm				36.219255277	-112.068836166	Yes	Grand Canyon National Park 2010a	
821	GCNP-1	WALL002		Wall Creek at Source			Grand Canyon - North Rim	Perched	Spring	Muav LS				36.165319548	-112.023197507	Yes	Grand Canyon National Park 2010a	
822	GCWC-02	GCNP-19		Middle Big Spring; A-34-01 26AC			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Perennial	Contact		36.31862	-112.2595	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of Big Springs Canyon Near Lancelot Point, this is The Mid Canyon Spring
823	GCWC-02	GCNP-20		North Big Spring; A-34-01 26AA			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Ephemeral	Contact		36.32161	-112.2539	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of Big Springs Canyon Near Lancelot Point, this is The Up Canyon Spring
824	GCWC-02	GCNP-6		Cliff Spring; A-32-04 27C			Grand Canyon - North Rim	Perched	Spring	Toroweap Fm	Perennial	Contact		36.125	-111.93333	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Approximately 1 Mile North of Cape Royal Parking Lot. Road Sign Identifies 1/4 Mile Trail to Spring
825	GCWC-02-Map	M-19		Cougar Spring?; B-33-01 03			Grand Canyon - North Rim	Perched	Spring					36.29068	-112.3792	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
826	GCWC-02-Map	M-106		B-34-01 24BDD			Grand Canyon - North Rim	Perched	Spring					36.33235	-112.35147	No	Grand Canyon Wildlands Council 2002	
827	GCWC-02-Map	M-107		B-34-01 24ACC			Grand Canyon - North Rim	Perched	Spring					36.33062	-112.34922	No	Grand Canyon Wildlands Council 2002	
828	GCWC-02-Map	M-248		Powell Spring; B-34-01 13BCC			Grand Canyon - North Rim	Perched	Spring					36.34567	-112.3578	No	Grand Canyon Wildlands Council 2002	
829	GCWC-02-Map	M-249		B-34-01 34			Grand Canyon - North Rim	Perched	Spring					36.30091	-112.38583	No	Grand Canyon Wildlands Council 2002	No Spring on Topo
830	NURE	23002	1	Amos Spring; B-30-12 36DC			Grand Canyon - West	Perched	Spring					35.941386754	-113.527271165	Yes	USGS 2009b	
830	GCWC-02-Map	M-186	2	Amos Spring; B-30-12 36DC			Grand Canyon - West	Perched	Spring					35.93984	-113.52628	No	Grand Canyon Wildlands Council 2002	
831	GCWC-02-Map	M-113		B-30-11 32B			Grand Canyon - West	Perched	Spring					35.9596	-113.49452	No	Grand Canyon Wildlands Council 2002	
832	GCWC-02-Map	M-15		Cottonwood Spring; B-30-12 13CA			Grand Canyon - West	Perched	Spring					35.9874	-113.52899	No	Grand Canyon Wildlands Council 2002	
833	GCWC-02-Map	M-66		Mathis Spring; B-31-12 20C			Grand Canyon - West	Perched	Spring					36.06475	-113.60327	No	Grand Canyon Wildlands Council 2002	
834	GCWC-02-Map	M-169		Suicide Spring; B-30.5-12 36C			Grand Canyon - West	Perched	Spring					36.02862	-113.53209	No	Grand Canyon Wildlands Council 2002	
835	GCWC-02-Map	M-194		Lower Spring; B-31-12 16AA			Grand Canyon - West	Perched	Spring					36.09245	-113.5725	No	Grand Canyon Wildlands Council 2002	
836	GCWC-02-Map	M-202		Middle Spring; B-32-10 26BB			Grand Canyon - West	Perched	Spring					36.14833	-113.3373	No	Grand Canyon Wildlands Council 2002	
837	GCWC-02-Map	M-203		End Spring; B-32-10 27BD			Grand Canyon - West	Perched	Spring					36.14457	-113.35127	No	Grand Canyon Wildlands Council 2002	
838	GCWC-02-Map	M-35		George Spring; B-32-10 23BA			Grand Canyon - West	Perched	Spring					36.16508	-113.33148	No	Grand Canyon Wildlands Council 2002	
839	GCWC-02-Map	M-201		Frog Spring; B-32-10 13DD			Grand Canyon - West	Perched	Spring					36.16691	-113.30692	No	Grand Canyon Wildlands Council 2002	
840	BLM-Legacy	LEG-15		Shultz Spring; B-32-09 18B			Grand Canyon - West	Perched	Spring					36.17508	-113.30171	Yes	BLM 2010d	Approximately 10 Pools,1'×3'/ Another Source is Located in Wash Bottom and Surfaces in 2-3 Places/Unique Variety of Vegetation:Ash,Red Bud,Alder,Locust,Etc./Spring Source See
841	GCWC-02-Map	M-198		Dripping Spring; B-32-10 20B			Grand Canyon - West	Perched	Spring					36.16145	-113.38696	No	Grand Canyon Wildlands Council 2002	
842	GCWC-02-Map	M-204		Lost Spring; B-32-10 20DA			Grand Canyon - West	Perched	Spring					36.15583	-113.37742	No	Grand Canyon Wildlands Council 2002	
843	GCWC-02-Map	M-216		Cupe Spring; B-33-10 27BD			Grand Canyon - West	Perched	Spring					36.23259	-113.33474	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
844	GCWC-02-Map	M-188		B-30-11 31			Grand Canyon - West	Perched	Spring					35.95131	-113.50724	No	Grand Canyon Wildlands Council 2002	
845	GCWC-02	KNF-17		Sowats Spring A; B-36-02 12DB			Jumpup Canyon	Perched	Spring	Toroweap Fm	Perennial	Contact		36.53101	-112.45519	Yes	Grand Canyon Wildlands Council 2002	Southern Kanab Plateau, East Side, North of Kwagant Hollow, Spring is Up Big Sowats Canyon from The Trail
846	GCWC-02	KNF-18		Sowats Spring B; B-36-02 12DC			Jumpup Canyon	Perched	Spring	Toroweap Fm	Perennial	Contact		36.52783	-112.45501	Yes	Grand Canyon Wildlands Council 2002	Southern Kanab Plateau, East Side, North of Kwagant Hollow, Spring is Down Big Sowats Canyon from Where The Trail Ends in The Bottom of The Canyon, and on The Eastern Slope.
847	GCWC-02	KNF-19		Sowats Spring; B-36-02 13AA			Jumpup Canyon	Perched	Spring	Toroweap Fm	Perennial	Contact		36.52443	-112.45532	Yes	Grand Canyon Wildlands Council 2002	Southern Kanab Plateau, East Side, North of Kwagant Hollow, Spring is Down Big Sowats Canyon from Where The Trail Ends in The Bottom of The Canyon, and on The Eastern Slope
848	GCWC-02-Map	M-122		White Spring; B-36-02 04D			Jumpup Canyon	Perched	Spring					36.54456	-112.50781	No	Grand Canyon Wildlands Council 2002	
849	GCWC-02-Map	M-29		East Box Elder Spring; B-36-02 03D			Jumpup Canyon	Perched	Spring					36.54603	-112.49281	No	Grand Canyon Wildlands Council 2002	
850	GCWC-02-Map	M-173		Upper Cottonwood Spring; B-36-02 17D			Jumpup Canyon	Perched	Spring					36.51811	-112.52331	No	Grand Canyon Wildlands Council 2002	
851	Springs_0103	WHITE		White Spring			Jumpup Canyon	Perched	Spring					36.5429511725	-112.526867274	No	BLM 2010c	
852	GCWC-02	GCNP-17	1	Kanabownits Spring; A-33-02 05BC			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact; Fault?		36.28682	-112.21295	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Kanabownits Canyon Adjacent to Widforss Point Road, Three Miles West of Crystal Creek
852	GWSI-1	361714112124601	2	Kanabownits Spring; A-33-02 05B			Kaibab Plateau	Perched	Spring	Toroweap Fm				36.287203074	-112.213507063	Yes	ADWR 2009b	
852	NWIS-2	361714112124601	3	A-33-02 05B UNSURVEYED			Kaibab Plateau	Perched	Spring	Toroweap Fm				36.2872033	-112.2135068	No	USGS 2010b	
852	GCNP-1	KANB001	4	Kanabownits Spring			Kaibab Plateau	Perched	Spring	Alluvium				36.287327903	-112.213386216	Yes	Grand Canyon National Park 2010a	
853	GCWC-02	GCNP-11	1	Robbers Roost Spring; A-33-03 04CC			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact; Fault?		36.28027	-112.08867	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Head of The Basin and Outlet Canyon Approximately Four and One Half Miles South of The Gcnp and Nknf Boundary and Off of Hwy 67
853	GWSI-1	361650112051601	2	Robber's Roost Spring; A-33-03 04C			Kaibab Plateau	Perched	Spring	Toroweap Fm				36.280538426	-112.088504195	Yes	ADWR 2009b	
853	NWIS-2	361650112051601	3	A-33-03 04C UNSURVEYED			Kaibab Plateau	Perched	Spring	Toroweap Fm				36.28053798	-112.088504	No	USGS 2010b	
853	GCNP-1	PHAN005	4	Robber's Roost			Kaibab Plateau	Perched	Spring	Toroweap Fm				36.280573673	-112.089067701	Yes	Grand Canyon National Park 2010a	
853	NWIS-1	361650112052001	5	Robbers Roost Spring			Kaibab Plateau	Perched	Spring					36.28055556	-112.08888889	Yes	USGS 2009a	
854	GCWC-02-Map	M-229	1	Lower Thompson Spring; A-33-03 22AD			Kaibab Plateau	Perched	Spring					36.24331	-112.05897	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
854	GWSI-1	361432112033201	2	Lower Thompson Spring; A-33-03 22D			Kaibab Plateau	Perched	Spring	Kaibab Ls				36.242204459	-112.05961401	Yes	ADWR 2009b	
854	NWIS-2	361432112033201	3	A-33-03 22D UNSURVEYED			Kaibab Plateau	Perched	Spring	Kaibab Ls				36.24220468	-112.0596139	No	USGS 2010b	
855	GCWC-02	GCNP-22	1	Tipover Spring; A-34-02 18AC			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact		36.34738	-112.22354	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Big Springs Canyon, 0.5 Miles South of Swamp Ridge Road
855	GWSI-1	362046112132101	2	Tipover Spring; A-34-02 18A			Kaibab Plateau	Perched	Spring	Toroweap Fm				36.346092993	-112.223229868	Yes	ADWR 2009b	
855	NWIS-2	362046112132101	3	A-34-02 18A UNSURVEYED			Kaibab Plateau	Perched	Spring	Toroweap Fm				36.3460931	-112.2232299	No	USGS 2010b	
856	GWSI-1	363720112202201	1	Mangum Spring; A-37-01 07BCB			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact		36.622209393	-112.340180931	No	ADWR 2009b	
856	NWIS-2	363720112202201	2	A-37-01 07BCB			Kaibab Plateau	Perched	Spring	Coconino Ss				36.6222096	-112.3401814	Yes	USGS 2010b	
856	GCWC-02-Map	M-119	3	Mangum Springs B; A-37-01 07BC			Kaibab Plateau	Perched	Spring					36.62255	-112.33971	No	Grand Canyon Wildlands Council 2002	
857	GWSI-1	363607112205201	1	Big Spring; B-37-01 13DCB			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact		36.601930826	-112.348514901	No	ADWR 2009b	
857	NWIS-2	363607112205201	2	B-37-01 13DCB			Kaibab Plateau	Perched	Spring	Coconino Ss				36.60193127	-112.3485147	Yes	USGS 2010b	
857	GCWC-02	KNF-22	3	Big Springs; B-37-01 13DC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact; Fault		36.60227	-112.34854	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, Big Springs Canyon, at Big Springs Administrative Site
857	NURE	GCBG501R	4				Kaibab Plateau	Perched	Spring	UNKN Ss				36.602286839	-112.348436904	Yes	USGS 2009b	
858	GCWC-02	GCNP-8	1	Neal Spring; A-33-04 18DA			Kaibab Plateau	Perched	Spring	Toroweap Fm		Unknown; contact?		36.25701	-112.00293	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Intersection of Cape Royal Road and Point Imperial Road, in Bright Angel Creek
858	GCNP-1	BRIG010	2	Neal Spring			Kaibab Plateau	Perched	Spring					36.256903164	-112.003174793	Yes	Grand Canyon National Park 2010a	
859	GCNP-1	OUTL002	1	Outlet Spring; B-33-03 29CA			Kaibab Plateau	Perched	Spring	Toroweap/ Kaibab				36.228033951	-112.100878682	Yes	Grand Canyon National Park 2010a	
859	GCWC-02-Map	M-232	2	Outlet Spring; B-33-03 29CA			Kaibab Plateau	Perched	Spring					36.22774	-112.10119	No	Grand Canyon Wildlands Council 2002	
860	GCWC-02	GCNP-9	1	Upper Thompson Spring; A-33-03 14BC			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact		36.25937	-112.0558	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, in Thompson Canyon, Eight Miles South of The Gcnp and Nknf Boundary Off of Hwy 67
860	GCNP-1	THOM001	2	Upper Thompson Spring			Kaibab Plateau	Perched	Spring	Kaibab LS				36.259243994	-112.055900682	Yes	Grand Canyon National Park 2010a	
861	GCWC-02-Map	M-118	1	Mangum Springs A; B-37-01 12AA			Kaibab Plateau	Perched	Spring					36.62554	-112.34509	No	Grand Canyon Wildlands Council 2002	
861	NURE	GCBG502R	2				Kaibab Plateau	Perched	Spring	UNKN Ss				36.625087425	-112.345837194	Yes	USGS 2009b	
862	GCWC-02	KNF-21	1	Castle Spring; A-37-01 19CC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact; Fracture		36.58626	-112.34168	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Castle Canyon, One Mile South of Big Springs Administrative Site
862	NURE	GCBG504R	2				Kaibab Plateau	Perched	Spring	UNKN Ss				36.585786472	-112.34183638	Yes	USGS 2009b	
863	GCWC-02	GCNP-13		Spring; A-33-03 20AA			Kaibab Plateau	Perched	Spring	Kaibab Ls	Ephemeral	Contact		36.25085	-112.0942	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, 3.2 Miles West of Hwy 67 on Widforss Point Road, Approximately One Mile South of The Basin

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
864	GCWC-02	GCNP-14		Basin Spring; A-33-03 08CC			Kaibab Plateau	Perched	Spring	Coconino Ss	Ephemeral	Contact; Fault?		36.26666	-112.10759	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Approximately Four Miles West of Hwy 67 Off of Widforss Point Road, in The Basin
865	GCWC-02	GCNP-16		Milk Creek Spring; A-33-02 12CB			Kaibab Plateau	Perched	Spring	Toroweap Fm	Perennial	Contact		36.27097	-112.1438	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, Approximately 7.5 Miles West of Hwy 67 Off of Widforss Point Road, in Milk Creek Approximately 3/4 Mile North of Widforss Point Road
866	GCWC-02	GCNP-5		No Name spring; A-33-03 26BB			Kaibab Plateau	Perched	Spring	Toroweap Fm		Contact		36.23396	-112.05162	Yes	Grand Canyon Wildlands Council 2002	Southern Kaibab Plateau, on Cape Royal Road Approximately 0.4 Miles Northeast of Hwy 67
867	GCWC-02	KNF-101		Timp Spring; A-35-01 33DB			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact		36.38757	-112.2953	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Timp Canyon
868	GCWC-02	KNF-14		Parissawampitts Spring; A-35-01 20CC			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact		36.41305	-112.31705	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Parissawampitts Canyon
869	GCWC-02	KNF-15		Bee Spring; A-35-01 08BA			Kaibab Plateau	Perched	Spring	Kaibab Ls		Contact		36.4505	-112.31848	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Indian Hollow Canyon
870	GCWC-02	KNF-20		Mourning Dove Spring; B-37-01 12DC			Kaibab Plateau	Perched	Spring	Toroweap Fm		Contact		36.61659	-112.34795	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, Side Canyon to Big Springs Canyon, One Mile North of Big Springs Administrative Site
871	GCWC-02	KNF-11		Quaking Aspen Spring; A-34-01 03BA			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact		36.3801	-112.28334	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Quaking Aspen Canyon
872	GCWC-02	KNF-12		Watts Spring; A-34-01 03AB			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact		36.37971	-112.27575	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Quaking Aspen Canyon
873	GCWC-02-Map	M-62		Lower Two Spring; A-34-01 08			Kaibab Plateau	Perched	Spring					36.36639	-112.30713	No	Grand Canyon Wildlands Council 2002	
874	GCWC-02	KNF-100		Upper Two Spring; A-34-01 09BA			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact		36.36491	-112.29853	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Side Canyon to Lower Quaking Aspen Canyon
875	GCWC-02-Map	M-46		Ikes Spring; A-34-01 15			Kaibab Plateau	Perched	Spring					36.34863	-112.27214	No	Grand Canyon Wildlands Council 2002	
876	GCWC-02	KNF-13		Pasture Spring; A-34-01 04BD			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact; Fracture		36.37799	-112.29821	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, West Side, in Quaking Aspen Canyon
877	GCWC-02-Map	M-262		Bear Spring; A-34-02 03C			Kaibab Plateau	Perched	Spring					36.36995	-112.17542	No	Grand Canyon Wildlands Council 2002	
878	GCWC-02-Map	M-263		Fawn Spring; A-34-02 14DC			Kaibab Plateau	Perched	Spring					36.33792	-112.15145	No	Grand Canyon Wildlands Council 2002	
879	GCWC-02-Map	M-167		South Canyon Spring; A-34-03 13CCC			Kaibab Plateau	Perched	Spring					36.33809	-112.03745	No	Grand Canyon Wildlands Council 2002	
880	GCWC-02-Map	M-345		Mangum Springs C; A-37-01 07BC			Kaibab Plateau	Perched	Spring					36.62187	-112.33896	No	Grand Canyon Wildlands Council 2002	
881	GCWC-02-Map	M-152		Riggs Spring or Canyon??; A-37-01 31D			Kaibab Plateau	Perched	Spring					36.55987	-112.32671	No	Grand Canyon Wildlands Council 2002	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
882	GCWC-02-Map	M-282		Crazy Jug Spring; B-35-01 14CB			Kaibab Plateau	Perched	Spring					36.43131	-112.37688	No	Grand Canyon Wildlands Council 2002	
883	GCWC-02-Map	M-281		Squaw Spring; A-35-01 34B			Kaibab Plateau	Perched	Spring					36.39511	-112.28521	No	Grand Canyon Wildlands Council 2002	
884	GCWC-02	KNF-3		Crystal Spring; A-35-03 32A			Kaibab Plateau	Perched	Spring	Kaibab Ls	Perennial	Contact		36.39038	-112.09653	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, Approximately 2.5 Miles East of Kaibab Lodge and Hwy 67
885	GCWC-02-Map	M-304		North Canyon Spring; A-35-03 28CD			Kaibab Plateau	Perched	Spring					36.39708	-112.08355	No	Grand Canyon Wildlands Council 2002	
886	GCWC-02	KNF-5		North Canyon Spring upper; A-35-03 28BBB			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact		36.40992	-112.08963	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, The Head of and in North Canyon
887	GCWC-02	KNF-7		North Canyon Spring middle; A-35-03 28BDA			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact		36.40522	-112.08342	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, The Head of and in North Canyon
888	GCWC-02	KNF-6		North Canyon Spring lower; A-35-03 28DBC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact		36.40096	-112.08059	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, The Head of and in North Canyon
889	GCWC-02	KNF-6A		North Canyon Spring all; A-35-03 28CAC			Kaibab Plateau	Perched	Spring	Coconino Ss	Perennial	Contact		36.39989	-112.08578	Yes	Grand Canyon Wildlands Council 2002	Central Kaibab Plateau, The Head of and in North Canyon
890	GCWC-02-Map	M-303		North Canyon Spring; A-35-03 28CDC			Kaibab Plateau	Perched	Spring					36.39617	-112.08493	No	Grand Canyon Wildlands Council 2002	
891	GCWC-02-Map	M-346		Mangum Springs; A-37-01 07BDD			Kaibab Plateau	Perched	Spring					36.62059	-112.33689	No	Grand Canyon Wildlands Council 2002	
892	GCWC-02-Map	M-264		South Big Spring; A-34-02 16AA			Kaibab Plateau	Perched	Spring					36.35091	-112.18537	No	Grand Canyon Wildlands Council 2002	
893	GCWC-02-Map	M-147		Oquer Spring; A-36-01 13A			Kaibab Plateau	Perched	Spring					36.52398	-112.24191	No	Grand Canyon Wildlands Council 2002	
894	GCWC-02-Map	M-266		A-34-02 19			Kaibab Plateau	Perched	Spring					36.3305	-112.22603	No	Grand Canyon Wildlands Council 2002	
895	NHD-1	124574533					Little Col. River	Perched	Spring					36.0945898106	-111.67512527	No	USGS 2007	
896	GWSI-1	361824113240801	1	Schutz Spring; B-34-10 31ABD			Shivwits Plateau	Perched	Spring	Basaltic Flows				36.306647401	-113.402993269	No	ADWR 2009b	
896	NWIS-2	361824113240801	2	B-34-10 31ABD			Shivwits Plateau	Perched	Spring					36.30664707	-113.4029935	No	USGS 2010b	
896	GCWC-02-Map	M-197	3	Schultz Spring; B-34-10 31AA			Shivwits Plateau	Perched	Spring					36.30626	-113.40316	No	Grand Canyon Wildlands Council 2002	
897	BLM-Legacy	LEG-4	1	Dansil Spring; B-32-11 10BA			Shivwits Plateau	Perched	Spring					36.19269	-113.45631	Yes	BLM 2010d	No State Water Rights Filing
897	Hopkins-84a	GW029W	2				Shivwits Plateau	Perched	Spring					36.192759251	-113.456324792	Yes	Hopkins et al. 1984a	
898	BLM-Legacy	LEG-5	1	Mud Spring; B-32-11 02CA			Shivwits Plateau	Perched	Spring					36.20107	-113.44021	Yes	BLM 2010d	No State Water Rights Filing
898	Hopkins-84a	GW030W	2				Shivwits Plateau	Perched	Spring					36.201092377	-113.440769014	Yes	Hopkins et al. 1984a	
899	GCWC-02	BLM 166	1	Grassy Spring; B-33-11 09CDD			Shivwits Plateau	Perched	Spring	Moenkopi Fm	Perennial	Contact		36.26727	-113.47855	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Shivwits Plateau, Southwest and on Top of Grassy Mountain
899	BLM-Legacy	LEG-10	2	Grassy Spring; B-33-11 09CDD			Shivwits Plateau	Perched	Spring					36.26727	-113.47855	Yes	BLM 2010d	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
899	NURE	GCCC502R	3				Shivwits Plateau	Perched	Spring	KBBL Carbonate				36.267480064	-113.478770437	Yes	USGS 2009b	
899	Hopkins-84a	GW034W	4				Shivwits Plateau	Perched	Spring					36.26720226	-113.479937137	Yes	Hopkins et al. 1984a	
900	GCWC-02	BLM 149	1	Hidden Spring; B-36-12 31CCC			Shivwits Plateau	Perched	Spring	Toroweap Fm - Hermit Sh	Perennial	Contact		36.46979	-113.62869	Yes	Grand Canyon Wildlands Council 2002	Western Az Strip, Hidden Rim Area, Hidden Canyon
900	BLM-Legacy	LEG-47	2	Hidden Spring; B-36-12 31CC			Shivwits Plateau	Perched	Spring					36.46979	-113.62869	Yes	BLM 2010d	Additional Jdr:4707//Additional Uses:36,12,31,Swsw/36,12,31 ,Nenw/36,12,30,Sese//Spring Fills Storage Which Services 2 Allotments
901	BLM-Legacy	LEG-7		Tungsten Spring; B-33-11 23AA			Shivwits Plateau	Perched	Spring					36.25093	-113.43504	Yes	BLM 2010d	Pipe and Trough Inoperative
902	GCWC-02-Map	M-59		Lower Hidden Spring; B-36-12 36DD			Shivwits Plateau	Perched	Spring					36.47278	-113.63439	No	Grand Canyon Wildlands Council 2002	
903	GCWC-02-Map	M-287		B-35-12 06			Shivwits Plateau	Perched	Spring					36.46327	-113.62038	No	Grand Canyon Wildlands Council 2002	
904	GCWC-02-Map	M-181		Willow Spring; B-34-06 32D			Tuckup Canyon	Perched	Spring					36.30157	-112.95598	No	Grand Canyon Wildlands Council 2002	
905	GCWC-02-Map	M-236		Dome Spring; B-33-06 01C			Tuckup Canyon	Perched	Spring					36.28335	-112.8934	No	Grand Canyon Wildlands Council 2002	
906	GCWC-02-Map	M-108		B-34-05 32C			Tuckup Canyon	Perched	Spring					36.30151	-112.8575	No	Grand Canyon Wildlands Council 2002	
907	GCWC-02-Map	M-237		Tule Spring; B-33-06 09ADD			Tuckup Canyon	Perched	Spring					36.27661	-112.93211	No	Grand Canyon Wildlands Council 2002	
908	GWSI-1	365348113191001	1	Ruesch Spring; B-40-10 01ACC			Uinkaret Plateau - North	Perched	Spring	Alluvium		Seepage of Filtration		36.896650778	-113.320226905	Yes	ADWR 2009b	
908	NWIS-2	365348113191001	2	B-40-10 01ACC			Uinkaret Plateau - North	Perched	Spring	Holocene Alluvium				36.89665045	-113.3202273	No	USGS 2010b	
909	GWSI-1	365637113143801	1	Antelope Spring; B-41-09 23BCB			Uinkaret Plateau - North	Perched	Spring	Moenkopi Fm		Seepage of Filtration		36.943595366	-113.24466958	No	ADWR 2009b	
909	BLM-Legacy	LEG-249	2	Antelope Spring; B-41-09 23BBC			Uinkaret Plateau - North	Perched	Spring					36.94387	-113.24456	Yes	BLM 2010d	
909	NWIS-2	365637113143801	3	B-41-09 23BCB			Uinkaret Plateau - North	Perched	Spring	Moenkopi Fm				36.94359548	-113.2446695	No	USGS 2010b	
910	NURE	GCAC503R					Uinkaret Plateau - North	Perched	Spring	KBBL Other				36.895183839	-113.313482722	Yes	USGS 2009b	
911	BLM-Legacy	LEG-251		Antelope Seeps South; B-41-09 23BBC			Uinkaret Plateau - North	Perched	Spring					36.94387	-113.24456	Yes	BLM 2010d	
912	BLM-Legacy	LEG-247		Antelope Seeps South-West; B-41-09 23BBC			Uinkaret Plateau - North	Perched	Spring					36.94387	-113.24456	Yes	BLM 2010d	
913	BLM-Legacy	LEG-242		Water Canyon Spring; B-41-07 07DC			Uinkaret Plateau - North	Perched	Spring					36.96437	-113.08743	Yes	BLM 2010d	
914	BLM-Legacy	LEG-200		Cottonwood Canyon Seeps; B-41-10 25AA			Uinkaret Plateau - North	Perched	Spring					36.93113	-113.31961	Yes	BLM 2010d	
915	BLM-Legacy	LEG-248		Cottonwood Canyon Spring; B-41-09 30BB			Uinkaret Plateau - North	Perched	Spring					36.93117	-113.31345	Yes	BLM 2010d	Wet Area is 2 to 15 Feet Wide and About 2000 Feet Long. Cottonwoods, Cattails, Sedges, Grasses, Ash.
916	BLM-Legacy	LEG-166		Ruesch Spring 1; B-40-10 01DB			Uinkaret Plateau - North	Perched	Spring					36.89514	-113.31854	Yes	BLM 2010d	Piped to Cement Dugout (Ferry Shrimp Habitat)
917	BLM-Legacy	LEG-250		Upper Antelope Spring; B-41-09 27ACD			Uinkaret Plateau - North	Perched	Spring					36.92723	-113.25087	Yes	BLM 2010d	Spring Flow is .07 Gallons per Minute

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
918	NWIS-2	354601111242601		03 098-08.80X15.98			Cameron, AZ	Perched	Well	Kaibab Ls			815	35.76694176	-111.4079224	Yes	USGS 2010b	
919	NWIS-2	355232111244901		03 098-09.18X08.57			Cameron, AZ	Perched	Well	Coconino Ss			658	35.87555075	-111.4143096	Yes	USGS 2010b	
920	NWIS-2	355226111245501		03 098-09.25X08.69			Cameron, AZ	Perched	Well	Coconino Ss			1012	35.8738841	-111.4159764	No	USGS 2010b	
921	NWIS-2	355226111245101		03 098-09.25X08.69A			Cameron, AZ	Perched	Well	Coconino Ss			1012	35.8738841	-111.4159764	Yes	USGS 2010b	
922	NWIS-2	355101111253901		03 098-09.96X10.32			Cameron, AZ	Perched	Well	Coconino Ss			856	35.85027346	-111.4284769	Yes	USGS 2010b	
923	NWIS-2	354605111294701		03 098-13.82X15.90			Cameron, AZ	Perched	Well	Supai Fm			1330	35.7680531	-111.4970899	Yes	USGS 2010b	
924	NWIS-2	354646111294801		03 098-13.94X15.20			Cameron, AZ	Perched	Well	Supai Fm			1292	35.77944175	-111.4973675	No	USGS 2010b	
925	NWIS-2	354517111275901		A-27-09 06AAD			Cameron, AZ	Perched	Well	Supai Fm				35.75472	-111.4670898	No	USGS 2010b	
926	NWIS-2	354510111280101		A-27-09 06ADB			Cameron, AZ	Perched	Well	Supai Fm			1600	35.75194229	-111.4693121	Yes	USGS 2010b	
927	NWIS-2	354442111281501		A-27-09 06DCA1			Cameron, AZ	Perched	Well	Supai Fm			1408	35.74499804	-111.4715345	Yes	USGS 2010b	
928	NWIS-2	354440111282001		A-27-09 06DCA2			Cameron, AZ	Perched	Well	Supai Fm			1500	35.7444425	-111.470979	Yes	USGS 2010b	
929	NWIS-2	354420111282001		A-27-09 07ABB1			Cameron, AZ	Perched	Well	Coconino Ss			1613	35.74194259	-111.4770903	Yes	USGS 2010b	
930	NWIS-2	354430111282701		A-27-09 07ABB2			Cameron, AZ	Perched	Well	Supai Fm			1500	35.7416648	-111.474868	No	USGS 2010b	
931	NWIS-2	354421111282101		A-27-09 07BAA			Cameron, AZ	Perched	Well	Supai Fm			1450	35.73916487	-111.4732014	No	USGS 2010b	
932	NWIS-2	354350111235001		A-27-09 11DDD			Cameron, AZ	Perched	Well	Coconino Ss			1613	35.72944259	-111.3962564	Yes	USGS 2010b	
933	NWIS-2	354257111254001		A-27-09 15CCC			Cameron, AZ	Perched	Well	Supai Fm			2165	35.71583198	-111.4284793	No	USGS 2010b	
934	NWIS-2	353054111511001		A-25-05 27CCB			Coconino Plateau - East	Perched	Well				320	35.515004	-111.8534925	No	USGS 2010b	
935	NWIS-2	353210111462401		A-25-06 20ACC			Coconino Plateau - East	Perched	Well	Volcanics			139	35.5361158	-111.7740465	No	USGS 2010b	
936	NWIS-2	353226111463001		A-25-06 20BAA			Coconino Plateau - East	Perched	Well	Holocene Alluvium			60	35.5405601	-111.7757131	No	USGS 2010b	
937	NWIS-2	353226111465401		A-25-06 20BBB			Coconino Plateau - East	Perched	Well	Kaibab Ls			437	35.54055997	-111.7823799	Yes	USGS 2010b	
938	NWIS-2	353208111462801		A-25-06 20BDD			Coconino Plateau - East	Perched	Well	Volcanics			112	35.53556027	-111.7751576	Yes	USGS 2010b	
939	NWIS-2	353206111462901		A-25-06 20CAA			Coconino Plateau - East	Perched	Well	Volcanics				35.5350047	-111.7754354	No	USGS 2010b	
940	NWIS-2	353110111462001		A-25-06 29			Coconino Plateau - East	Perched	Well				730	35.5194497	-111.7729356	No	USGS 2010b	
941	NWIS-2	353030111455001		A-25-06 33BCB			Coconino Plateau - East	Perched	Well				450	35.5083391	-111.7646024	No	USGS 2010b	
942	NWIS-2	353119111381101		A-25-07 27BDB			Coconino Plateau - East	Perched	Well				468	35.52194949	-111.6371	No	USGS 2010b	
943	NWIS-2	353410111284001		A-25-09 06CCD			Coconino Plateau - East	Perched	Well	Supai Fm			1788	35.5700029	-111.4801513	Yes	USGS 2010b	
944	NWIS-2	353110111221001		A-25-10 30BDB			Coconino Plateau - East	Perched	Well	Coconino Ss			904	35.52000357	-111.3723718	Yes	USGS 2010b	
945	NWIS-2	353914112082101		A-26-02 11AAD			Coconino Plateau - East	Perched	Well				1800	35.65388487	-112.1398877	No	USGS 2010b	
946	NWIS-2	354000111295001		A-26-08 01BCD			Coconino Plateau - East	Perched	Well	Supai Fm			1550	35.6644448	-111.4979264	Yes	USGS 2010b	
947	NWIS-2	353517111305401		A-26-08 35CBD			Coconino Plateau - East	Perched	Well	Supai Fm			1662	35.58805814	-111.515707	No	USGS 2010b	
948	NWIS-2	353817111251001		A-26-09 15DAD			Coconino Plateau - East	Perched	Well	Supai Fm			1250	35.6316675	-111.4129257	Yes	USGS 2010b	
949	NWIS-2	353520111260001		A-26-09 33CAD			Coconino Plateau - East	Perched	Well	Supai Fm			1440	35.58666887	-111.4395942	Yes	USGS 2010b	
950	NWIS-2	353837111195801		A-26-10 09CDA			Coconino Plateau - East	Perched	Well	Coconino Ss			1440	35.6436112	-111.3334795	Yes	USGS 2010b	
951	NWIS-2	353523111222701		A-26-10 31CBA			Coconino Plateau - East	Perched	Well	Coconino Ss			1009	35.58972396	-111.3748703	Yes	USGS 2010b	
952	NWIS-2	354830112260001		B-28-01 18C			Coconino Plateau - East	Perched	Well	Toroweap Fm			485	35.80832195	-112.4340655	No	USGS 2010b	
953	NWIS-2	355737113042701		B-18-08 12BBC			Coconino Plateau - West	Perched	Well				569	35.96026225	-113.0749238	No	USGS 2010b	
954	NWIS-2	353420112354001		B-25-03 03CC 1			Coconino Plateau - West	Perched	Well	Volcanics			140	35.57221858	-112.5951794	No	USGS 2010b	
955	NWIS-2	353420112354002		B-25-03 03CC2			Coconino Plateau - West	Perched	Well	Volcanics			130	35.57221858	-112.5951794	Yes	USGS 2010b	
956	NWIS-2	353500112420001		B-25-04 03BAA			Coconino Plateau - West	Perched	Well				250	35.58332876	-112.7007376	No	USGS 2010b	
957	NWIS-2	353420112415001		B-25-04 03CDD			Coconino Plateau - West	Perched	Well	Volcanics			330	35.57221805	-112.6979595	No	USGS 2010b	
958	NWIS-2	353928112383001		B-26-03 19B			Coconino Plateau - West	Perched	Well	Kaibab Ls			354	35.6577707	-112.6424045	No	USGS 2010b	
959	NWIS-2	353740112372001		B-26-03 20BDA			Coconino Plateau - West	Perched	Well				98	35.6277719	-112.6229589	Yes	USGS 2010b	
960	NWIS-2	353640112420001		B-26-04 27BDA			Coconino Plateau - West	Perched	Well				207	35.61110556	-112.7007384	No	USGS 2010b	
961	NWIS-2	353610112422001		B-26-04 27CCC			Coconino Plateau - West	Perched	Well				340	35.60277249	-112.7062938	No	USGS 2010b	
962	NWIS-2	354520112515701		B-27-06 01ADC			Coconino Plateau - West	Perched	Well				128	35.7555448	-112.866582	No	USGS 2010b	
963	NWIS-2	360205113030801		B-40-07 16			Coconino Plateau - West	Perched	Well				265	36.03470529	-113.052979	No	USGS 2010b	
964	Wenrich-94	14A-W82		Fed by Frazier well; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Well	Tertiary gravel				35.79665493	-113.077978868	Yes	Wenrich et al. 1994	
965	Wenrich-94	57A+B-W82	1	XI Well; Tertiary Frazier Well gravel			Coconino Plateau - West	Perched	Well	Tertiary gravel				35.784432983	-113.114091123	Yes	Wenrich et al. 1994	
965	NURE	23024	2				Coconino Plateau - West	Perched	Well					35.783488603	-113.114057818	Yes	USGS 2009b	
966	NURE	GCDE501R					Coconino Plateau - West	Perched	Well	QTRN				36.017783595	-112.826749556	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
967	Wenrich-94	13A-W82		Unnamed well; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Well	Tertiary gravel				35.835820683	-113.093257308	Yes	Wenrich et al. 1994	
968	Wenrich-94	16A-W82		Unnamed well; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Well	Tertiary gravel				35.810265649	-113.051033619	Yes	Wenrich et al. 1994	
969	NWIS-2	360021113191001		B-39-10 25ABB			Grand Canyon - West	Perched	Well	Hermit Sh			300	36.00581839	-113.3202095	No	USGS 2010b	
970	NWIS-2	361352112413201		B-33-04 22 UNSURVEYED			Havasu Creek	Perched	Well	Holocene Alluvium			152	36.2310934	-112.6929682	Yes	USGS 2010b	
971	NWIS-2	361355112413001		B-33-04 22 UNSURVEYED			Havasu Creek	Perched	Well	Holocene Alluvium			152	36.23192675	-112.6924126	No	USGS 2010b	
972	NWIS-2	361354112413301		B-33-04 22 UNSURVEYED2			Havasu Creek	Perched	Well	Holocene Alluvium			125	36.23164898	-112.693246	No	USGS 2010b	
973	NWIS-2	361412112411901		B-33-04 23BBB			Havasu Creek	Perched	Well	Holocene Alluvium			20	36.2366489	-112.689357	No	USGS 2010b	
974	NWIS-2	361356112411901		B-33-04 23BCC1			Havasu Creek	Perched	Well	Holocene Alluvium			90	36.2322045	-112.6893569	Yes	USGS 2010b	
975	NWIS-2	361356112411902		B-33-04 23BCC2			Havasu Creek	Perched	Well	Holocene Alluvium			90	36.2322045	-112.6893569	Yes	USGS 2010b	
976	NWIS-2	362445113210801		B-35-10 22CDD			Hurricane Valley	Perched	Well	Kaibab Ls			1164	36.4124808	-113.352997	No	USGS 2010b	
977	NWIS-2	362510113192701		B-35-10 24CBB			Hurricane Valley	Perched	Well	Kaibab Ls			382	36.41942537	-113.324941	No	USGS 2010b	
978	NWIS-2	362436113200501		B-35-10 26BAA			Hurricane Valley	Perched	Well	Kaibab Ls			420	36.40998087	-113.3354965	No	USGS 2010b	
979	NWIS-2	363255113211501		B-36-10 03			Hurricane Valley	Perched	Well	Kaibab Ls			32	36.54859257	-113.3549463	No	USGS 2010b	
980	NWIS-2	364337113241301		B-38-10 06A			Hurricane Valley	Perched	Well	Kaibab Ls			365	36.72692706	-113.4043978	No	USGS 2010b	
981	NWIS-2	362602112133001		A-24-02 30BCD			Kaibab Plateau	Perched	Well				1350	36.4338724	-112.2257308	No	USGS 2010b	
982	NWIS-2	362202112072501		A-34-03 06C UNSURVEYED			Kaibab Plateau	Perched	Well	Holocene Alluvium			10	36.3672054	-112.1243392	No	USGS 2010b	
983	NWIS-2	362153112050501		A-34-03 09B UNSURVEYED			Kaibab Plateau	Perched	Well	Holocene Alluvium			10	36.36470568	-112.0854495	Yes	USGS 2010b	
984	NWIS-2	362503112075001		A-35-02 24ADC			Kaibab Plateau	Perched	Well	Holocene Alluvium			12	36.4174838	-112.1312844	No	USGS 2010b	
985	NWIS-2	362502112075101		A-35-02 24DAB1			Kaibab Plateau	Perched	Well	Holocene Alluvium			12	36.417206	-112.1315622	No	USGS 2010b	
986	NWIS-2	362501112074901		A-35-02 24DAB2			Kaibab Plateau	Perched	Well	Holocene Alluvium			18	36.41692825	-112.1310066	No	USGS 2010b	
987	NWIS-2	364141112150301		A-38-01 14ADD			Kaibab Plateau	Perched	Well				704	36.69471236	-112.2515679	No	USGS 2010b	
988	NWIS-2	364251112130001		A-38-02 07AAA			Kaibab Plateau	Perched	Well	Kaibab Ls				36.71415695	-112.2174007	No	USGS 2010b	
989	NURE	GCCH501R					Kaibab Plateau	Perched	Well	UNKN Carbonate				36.463483953	-112.246631451	Yes	USGS 2009b	
990	NWIS-2	361637111350301		03 061-04.70X15.38			Painted Desert	Perched	Well	Coconino Ss			1292	36.2769322	-111.5848728	No	USGS 2010b	
991	Wenrich-94	45A+B-W82	1	PMG Well (Truxton)			Peach Springs, AZ	Perched	Well	Quat. and Tert. gravel				35.496380972	-113.557162059	Yes	Wenrich et al. 1994	
991	NURE	23007	2				Peach Springs, AZ	Perched	Well					35.496392071	-113.557273162	Yes	USGS 2009b	
992	Wenrich-94	73A+B-W82		Truxton Well			Peach Springs, AZ	Perched	Well	Quat. and Tert. gravel				35.495547855	-113.536050549	Yes	Wenrich et al. 1994	
993	NWIS-2	360908113345201		B-32-12 21CDD			Shivwits Plateau	Perched	Well	Holocene Alluvium			26	36.15220578	-113.5818848	No	USGS 2010b	
994	NWIS-2	361521113340401		B-33-12 15CDA			Shivwits Plateau	Perched	Well	Holocene Alluvium			35	36.2558145	-113.5685512	No	USGS 2010b	
995	NWIS-2	361942113311701		B-34-12 24DDA			Shivwits Plateau	Perched	Well	Supai Fm			2120	36.3283137	-113.5221635	No	USGS 2010b	
996	NWIS-2	362332113320901		B-35-12 36B			Shivwits Plateau	Perched	Well				10.5	36.39220279	-113.5366114	No	USGS 2010b	
997	NWIS-2	365739113115701		B-41-08 18BAA			Uinkaret Plateau - North	Perched	Well				1522	36.9608177	-113.1999454	No	USGS 2010b	
998	NWIS-2	361025113071100		Artesian Spring at River Mile 182; B-32-08 10 UNSURVEYED	182		Grand Canyon - Central	Regional	Spring	Muav Ls				36.17359288	-113.1204832	Yes	USGS 2010b	
999	NWIS-2	360917113064200		B-32-08 14 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Redwall Ls				36.1547042	-113.112427	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1000	NWIS-2	360957113080200		B-32-08 22 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.1658152	-113.1346503	Yes	USGS 2010b	
1001	GCWC-02	GCNP-112	1	Fern Glen; B-33-06 15A			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Contact		36.26244	-112.91944	Yes	Grand Canyon Wildlands Council 2002	in Fern Glen Canyon, Approximately 0.25 Miles from The Colorado River at River Mile 168
1001	GWSI-1	361543112550301	2	B-33-06 15A			Grand Canyon - Central	Regional	Spring	Muav Ls				36.261925552	-112.918254271	Yes	ADWR 2009b	
1001	NWIS-2	361543112550301	3	B-33-06 15A UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.261926	-112.9182543	No	USGS 2010b	
1001	Peterson-77	CF-14	4	Fern Glen Canyon; RM168	168		Grand Canyon - Central	Regional	Spring	Muav Ls				36.261925953	-112.918254272	Yes	Peterson et al. 1977	
1001	Taylor-04	FERN	5	Fern Glen			Grand Canyon - Central	Regional	Spring	Muav Ls				36.2615965431	-112.9178228867	Yes	Taylor et al. 2004	Reported Location Utm (327710,4014470)
1002	NWIS-2	361310112580400		Mohawk Canyon; B-33-06 30 1 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.21942584	-112.9685333	Yes	USGS 2010b	
1003	NWIS-2	361252112580901	1	Mohawk Spring; B-33-06 30 2 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.21442587	-112.9699222	Yes	USGS 2010b	
1003	Wenrich-94	50A-W82	2	Mohawk Spring			Grand Canyon - Central	Regional	Spring	Muav Ls				36.213037028	-112.971033376	Yes	Wenrich et al. 1994	
1004	NWIS-2	361148113045900		Warm Spring; B-33-08 31 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.1966481	-113.0838153	Yes	USGS 2010b	
1005	STORET-1	GRCA_FIT_ MATK02	1	Matkatamiba Spring			Grand Canyon - Central	Regional	Spring	Redwall Ls		Contact; Fault		36.3245132	-112.6598047	No	USEPA 2010	Matkatamiba Spring Emerges from a Seam at The Contact Between Whitmore Wash and Thunder Spring Members of Redwall Limestone, in The Main Channel of Matkatamiba Canyon Immediately Downstream from The Sinyala Fault. The Site is Within The Boundary of Grand
1005	Fitz-96	MATK	2	Matkatamiba Spring			Grand Canyon - Central	Regional	Spring	Bright Angel Sh - Muav Ls	Intermittent			36.3245132	-112.6598047	Yes	Fitzgerald 1996	
1005	NWIS-2	361928112393201	3	B-34-03 30 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Redwall Ls				36.3244269	-112.6596347	Yes	USGS 2010b	
1006	GWSI-1	362044112401501	1	B-34-04 13D			Grand Canyon - Central	Regional	Spring	Muav Ls				36.345538681	-112.671579542	Yes	ADWR 2009b	
1006	NWIS-2	362044112401501	2	B-34-04 13D UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.34553824	-112.6715799	No	USGS 2010b	
1006	Peterson-77	CF-10	3	RM147.9	147.9		Grand Canyon - Central	Regional	Spring	Muav Ls				36.345538285	-112.671579843	Yes	Peterson et al. 1977	
1006	GCWC-02	GCNP-111	4	Mile 148 upper; B-34-04 13C			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Contact		36.34603	-112.67064	Yes	Grand Canyon Wildlands Council 2002	Colorado River Mile 147.8, Right Site at 25 Meters from River
1007	GWSI-1	362425112254601	1	Tapeats Spring; B-35-01 29B			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Tubular Cave		36.406926672	-112.430181362	Yes	ADWR 2009b	
1007	NWIS-2	362425112254601	2	B-35-01 29B UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.4069271	-112.4301818	Yes	USGS 2010b	
1007	GCWC-02-Map	M-283	3	Tapeats Spring; B-35-01 29BB			Grand Canyon - Central	Regional	Spring					36.40638	-112.42988	No	Grand Canyon Wildlands Council 2002	
1008	GWSI-1	362346112272801	1	Thunder Spring; B-35-02 25D			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Tubular Cave		36.396093491	-112.458516308	No	ADWR 2009b	
1008	NWIS-2	362346112272801	2	B-35-02 25D UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.3960936	-112.458516	Yes	USGS 2010b	
1008	GCWC-02-Map	M-184	3	Thunder Spring; B-35-02 25DCC			Grand Canyon - Central	Regional	Spring					36.39613	-112.4585	No	Grand Canyon Wildlands Council 2002	
1009	NWIS-2	361518112523901		B-36-06 24 UNSURVEYED			Grand Canyon - Central	Regional	Spring	Muav Ls				36.2549818	-112.8782527	Yes	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1010	GCNP-1	COLO052		Beecher Spring			Grand Canyon - Central	Regional	Spring					36.167222222	-113.141388889	Yes	Grand Canyon National Park 2010a	
1011	GCWC-02	GCNP-108	1	Deer Creek upper falls; B-35-02 27C			Grand Canyon - Central	Regional	Spring	Muav Ls	Perennial	Fracture		36.39978	-112.50198	Yes	Grand Canyon Wildlands Council 2002	in Deer Creek Canyon, Approximately 100 Meters from The Colorado River at River Mile 136.3 on Trail to Deer Canyon.
1011	GCNP-1	DEER003	2	Deer Creek Below Dutton Spring (waterfall source)			Grand Canyon - Central	Regional	Spring					36.3997222	-112.5019444	Yes	Grand Canyon National Park 2010a	
1012	GCNP-1	DEER005		Deer Creek near Upper/ Northern Source			Grand Canyon - Central	Regional	Spring	Muav-Bright Angel Sh				36.4013889	-112.5069444	Yes	Grand Canyon National Park 2010a	
1013	GCNP-1	DEER007		Deer Creek middle source spring (calculated Q)			Grand Canyon - Central	Regional	Spring					36.4002777	-112.5063888	Yes	Grand Canyon National Park 2010a	
1014	GCNP-1	DEER008		Deer Creek Dutton spring (calculated Q)			Grand Canyon - Central	Regional	Spring					36.4016666	-112.5063888	Yes	Grand Canyon National Park 2010a	
1015	Wenrich-94	76A-W82	1	Lava Falls (by cliff)			Grand Canyon - Central	Regional	Spring	Muav Ls				36.196119529	-113.081302574	Yes	Wenrich et al. 1994	
1015	Peterson-77	CF-15	2	Lava Falls; River Mile 179.3	179.3		Grand Canyon - Central	Regional	Spring	Muav Ls				36.194148186	-113.083815345	Yes	Peterson et al. 1977	
1016	Taylor-04	COVE-CAN		Cove Canyon			Grand Canyon - Central	Regional	Spring	Muav Ls				36.2456687725	-113.0152019877	Yes	Taylor et al. 2004	Reported Location Utm (318924,4012881)
1017	Taylor-04	KEYHOLE		Keyhole Spring			Grand Canyon - Central	Regional	Spring	Muav Ls				36.3795569166	-112.5823642888	Yes	Taylor et al. 2004	Reported Location Utm (358063,4027010)
1018	Taylor-04	MOHAWK-CAN		Mohawk Canyon			Grand Canyon - Central	Regional	Spring	Muav Ls				36.2246357352	-112.9672819154	Yes	Taylor et al. 2004	Reported Location Utm (323183,4010459)
1019	Taylor-04	RM147_SE		River Mile 147 Seep	147		Grand Canyon - Central	Regional	Spring	Muav Ls				36.3430506179	-112.675921931	Yes	Taylor et al. 2004	Reported Location Utm (349600,4023102)
1020	Taylor-04	SLIM-TCK-SP		Slimy Tick Spring			Grand Canyon - Central	Regional	Spring	Muav Ls				36.3255843881	-112.7540595973	Yes	Taylor et al. 2004	Reported Location Utm (342552,4021289)
1021	Wenrich-94	26A-W82		Rampart Springs			Grand Canyon - Central	Regional	Spring	Muav Ls				36.145009633	-113.109915787	Yes	Wenrich et al. 1994	
1022	Wenrich-94	51A-W82		National Canyon Spring			Grand Canyon - Central	Regional	Spring	Redwall Ls				36.213315326	-112.879363526	Yes	Wenrich et al. 1994	
1023	Wenrich-94	75A-W82		Warm Springs			Grand Canyon - Central	Regional	Spring	Muav Ls				36.196952793	-113.082413734	Yes	Wenrich et al. 1994	
1024	GCWC-02	GCNP-110		Mile 142 lower; B-35-03 27D			Grand Canyon - Central	Regional	Spring	Bright Angel Sh	Perennial	Contact		36.39778	-112.59897	Yes	Grand Canyon Wildlands Council 2002	Colorado River Mile 142, Right Site at 30 Meters from River
1025	GCWC-02-Map	M-298		Vaughn Springs; B-35-02 16			Grand Canyon - Central	Regional	Spring					36.42566	-112.50554	No	Grand Canyon Wildlands Council 2002	
1026	GCWC-02-Map	M-43		Hualapai Spring; B-35-02 19			Grand Canyon - Central	Regional	Spring					36.42208	-112.5467	No	Grand Canyon Wildlands Council 2002	
1027	NWIS-2	361403112314201		B-33-02 29 UNSURVEYED			Grand Canyon - East	Regional	Spring	Muav Ls				36.23414765	-112.5290733	Yes	USGS 2010b	
1028	NWIS-2	361143112270500	1	HP68 Royal Arch Creek at Mouth at Elves Chasm			Grand Canyon - East	Regional	Spring	Muav Ls				36.19525895	-112.4521255	Yes	USGS 2010b	
1028	GCNP-1	ROYA006	2	Royal Arch Creek at Elves Chasm			Grand Canyon - East	Regional	Spring	Tapeats Ss/ Travertine				36.196547604	-112.450664539	Yes	Grand Canyon National Park 2010a	
1029	GCNP-1	COLO126		Trilobite? Spring (below lower Fossil camp)			Grand Canyon - East	Regional	Spring	Bright Angel Sh				36.278109921	-112.515566508	Yes	Grand Canyon National Park 2010a	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1030	Taylor-04	RM125-SP		River Mile 125 Spring	125		Grand Canyon - East	Regional	Spring	Muav Ls				36.2636594662	-112.5231207658	Yes	Taylor et al. 2004	Reported Location Utm (363175,4014068)
1031	GWSI-1	361153112121501	1	Crytsal Spring; A-32-02 05D			Grand Canyon - North Rim	Regional	Spring	Alluvium	Perennial	Seepage of Filtration		36.19803711	-112.204895042	Yes	ADWR 2009b	
1031	NWIS-2	361153112121501	2	A-32-02 05D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Holocene Alluvium				36.19803666	-112.2048947	No	USGS 2010b	
1032	GWSI-1	361043112105501	1	Dragon Spring; A-32-02 09D			Grand Canyon - North Rim	Regional	Spring	Alluvium	Perennial	Seepage of Filtration		36.178592533	-112.182671314	Yes	ADWR 2009b	
1032	NWIS-2	361043112105501	2	A-32-02 09D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Holocene Alluvium				36.17859264	-112.1826718	No	USGS 2010b	
1033	GWSI-1	360910112074801	1	Phantom Spring; A-32-02 24D			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture		36.152760225	-112.130725718	Yes	ADWR 2009b	
1033	NWIS-2	360910112074801	2	A-32-02 24D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.15276	-112.1307257	No	USGS 2010b	
1034	GWSI-1	361143112020701	1	Roaring Spring; A-32-03 01C			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave		36.195260893	-112.036001817	No	ADWR 2009b	
1034	NWIS-2	361143112020701	2	A-32-03 01C UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.19526067	-112.0360016	Yes	USGS 2010b	
1035	GWSI-1	361125112034001	1	Transept Spring; A-32-03 10A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture		36.190260646	-112.061835395	Yes	ADWR 2009b	
1035	NWIS-2	361125112034001	2	A-32-03 10A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.1902604	-112.0618355	No	USGS 2010b	
1036	GWSI-1	361012112043501	1	Ribbon Spring; A-32-03 16D			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture		36.169982595	-112.077113527	Yes	ADWR 2009b	
1036	NWIS-2	361012112043501	2	A-32-03 16D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.16998259	-112.0771134	No	USGS 2010b	
1037	GWSI-1	360935112063601	1	Haunted Spring; A-32-03 19A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture		36.159704351	-112.110725273	Yes	ADWR 2009b	
1037	NWIS-2	360935112063601	2	A-32-03 19A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.15970457	-112.1107253	No	USGS 2010b	
1038	GWSI-1	361723112153601	1	Abyss River Spring; A-33-01 02A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave		36.289702709	-112.26073029	Yes	ADWR 2009b	
1038	NWIS-2	361723112153601	2	A-33-01 02A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.2897029	-112.2607303	No	USGS 2010b	
1039	GWSI-1	361257112013501	1	Emmett Spring; A-33-03 36A			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave		36.215815939	-112.027112882	Yes	ADWR 2009b	
1039	GCNP-1	BRIG005	2	Emmett Spring Source			Grand Canyon - North Rim	Regional	Spring					36.212946316	-112.023272169	No	Grand Canyon National Park 2010a	
1039	NWIS-2	361257112013501	3	A-33-03 36A UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.21581627	-112.0271128	No	USGS 2010b	
1040	GWSI-1	361320112003701	1	Angel Spring; A-33-04 30D			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Tubular Cave		36.222205106	-112.011001583	Yes	ADWR 2009b	
1040	NWIS-2	361320112003701	2	A-33-04 30D UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.2222053	-112.0110014	No	USGS 2010b	
1040	GCNP-1	BRIG004	3	Angel Spring			Grand Canyon - North Rim	Regional	Spring	Muav LS				36.22171776	-112.011648406	Yes	Grand Canyon National Park 2010a	
1041	GWSI-1	361808112180801	1	Shinumo Spring; A-34-01 33B			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture		36.302202991	-112.302953982	Yes	ADWR 2009b	
1041	NWIS-2	361808112180801	2	A-34-01 33B UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.3022032	-112.3029542	No	USGS 2010b	
1042	GWSI-1	361740112175501	1	Noble Spring; A-34-01 33C			Grand Canyon - North Rim	Regional	Spring	Muav Ls	Perennial	Fracture		36.294424848	-112.299342782	Yes	ADWR 2009b	
1042	NWIS-2	361740112175501	2	A-34-01 33C UNSURVEYED			Grand Canyon - North Rim	Regional	Spring	Muav Ls				36.29442529	-112.2993429	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1043	GCNP-1	ROAR004		Roaring Springs at GRCA inlet pipe			Grand Canyon - North Rim	Regional	Spring	Muav LS				36.1952778	-112.035	Yes	Grand Canyon National Park 2010a	
1044	GCWC-02-Map	M-110		A-32.5-03 35D			Grand Canyon - North Rim	Regional	Spring					36.19612	-112.0338	No	Grand Canyon Wildlands Council 2002	
1045	GCWC-02-Map	M-111		A-32.5-03 35D			Grand Canyon - North Rim	Regional	Spring					36.19532	-112.03293	No	Grand Canyon Wildlands Council 2002	
1046	GCWC-02-Map	M-214		Roaring Springs; A-32.5-03 35D			Grand Canyon - North Rim	Regional	Spring					36.19674	-112.03529	No	Grand Canyon Wildlands Council 2002	
1047	NWIS-2	361119112271501	1	Elves Chasm Spring; A-32-02 01 UNSURVEYED			Grand Canyon - South Rim	Regional	Spring	Redwall Ls				36.18859238	-112.4549033	Yes	USGS 2010b	
1047	Taylor-04	ELV-CH	2	Elves Chasm			Grand Canyon - South Rim	Regional	Spring	Muav Ls				36.1889449179	-112.4542929997	Yes	Taylor et al. 2004	Reported Location Utm (369234,4005685)
1048	NPS_All_Hydro	HP-8c					Grand Canyon - South Rim	Regional	Spring					36.1946206411	-112.341560761	No	Grand Canyon National Park 2010b	
1049	NPS_All_Hydro	HP-65a					Grand Canyon - South Rim	Regional	Spring					36.1856175423	-112.458221556	No	Grand Canyon National Park 2010b	
1050	Wenrich-94	28A-W82	1	Diamond Creek Spring (Upper Diamond Spring); B-27-09 15CDC			Grand Canyon - West	Regional	Spring	Redwall Ls				35.719990029	-113.23159471	Yes	Wenrich et al. 1994	
1050	NWIS-2	354311113135200	2	Diamond Creek Spring; B-27-09 15CDC			Grand Canyon - West	Regional	Spring	Redwall Ls				35.71971226	-113.2318725	Yes	USGS 2010b	
1051	NWIS-2	354248113153800	1	Diamond Spring; B-27-09 20ACB			Grand Canyon - West	Regional	Spring	Muav Ls				35.7133234	-113.261318	Yes	USGS 2010b	
1051	Wenrich-94	58A-W82	2	Diamond Spring			Grand Canyon - West	Regional	Spring	Muav Ls				35.713323371	-113.261040235	Yes	Wenrich et al. 1994	
1052	NWIS-2	354302113174700		B-27-10 24ABB			Grand Canyon - West	Regional	Spring	Muav Ls				35.71721195	-113.2971527	Yes	USGS 2010b	
1053	NWIS-2	354151113173601	1	Blue Mountain Seep; B-27-10 25ADC			Grand Canyon - West	Regional	Spring	Redwall Ls				35.69749009	-113.2940969	No	USGS 2010b	
1053	Wenrich-94	62A-W82	2	Blue Mountain Seep			Grand Canyon - West	Regional	Spring	Bright Angel Sh				35.696934514	-113.292707945	Yes	Wenrich et al. 1994	
1054	NWIS-2	354406113263400		Travertine Canyon Spring; B-27-11 10 UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls				35.73498826	-113.4435468	Yes	USGS 2010b	
1055	NWIS-2	354250113343800	1	Hindu Spring; B-27-12 20ACA			Grand Canyon - West	Regional	Spring	Muav Ls				35.71387756	-113.577996	Yes	USGS 2010b	
1055	NURE	23027	2				Grand Canyon - West	Regional	Spring					35.714088672	-113.578573815	Yes	USGS 2009b	
1056	NWIS-2	354550113313400		Bridge Canyon Spring; B-28-12 35 UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls				35.76387655	-113.526883	Yes	USGS 2010b	
1057	NWIS-2	355750113183600		Granite Park Spring; B-30-10 25 UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls				35.96387456	-113.3107647	Yes	USGS 2010b	
1058	NWIS-2	355750113183601		B-30-10 25 UNSURVEYED			Grand Canyon - West	Regional	Spring	Muav Ls				35.96387456	-113.3107647	No	USGS 2010b	
1059	NWIS-2	354855113183300		Granite Spring Canyon; UNSURVEYEDEYED			Grand Canyon - West	Regional	Spring	Muav Ls				35.81526579	-113.309931	Yes	USGS 2010b	
1060	Wenrich-94	78A+B-W82		Three Springs			Grand Canyon - West	Regional	Spring	Muav Ls				35.885542513	-113.293541844	Yes	Wenrich et al. 1994	
1061	Taylor-04	RM213-SP		River Mile 213 Spring	213		Grand Canyon - West	Regional	Spring	Bright Angel Sh				35.9185011765	-113.3358468389	Yes	Taylor et al. 2004	Reported Location Utm (289236,3977233)
1062	Wenrich-94	53A-W82		East Diamond Spring			Grand Canyon - West	Regional	Spring	Muav Ls				35.718878925	-113.254651124	Yes	Wenrich et al. 1994	
1063	Wenrich-94	5A-W82		Rocky Spring			Grand Canyon - West	Regional	Spring	Bright Angel Sh				35.749433026	-113.363821795	Yes	Wenrich et al. 1994	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1064	GCWC-02	GCNP-113		Spring Canyon; B-30-10 10B			Grand Canyon - West	Regional	Spring	Muav Ls	Perennial	Contact		36.01817	-113.35531	Yes	Grand Canyon Wildlands Council 2002	in Spring Canyon, Approximately 0.25 Miles from The Colorado River at River Mile 204
1065	GCWC-02-Map	M-199		Cedar Spring; B-32-10 23DA			Grand Canyon - West	Regional	Spring					36.15757	-113.32541	No	Grand Canyon Wildlands Council 2002	
1066	GCWC-02-Map	M-5		Cane Spring; B-32-09 22CD			Grand Canyon - West	Regional	Spring					36.15426	-113.2413	No	Grand Canyon Wildlands Council 2002	
1067	GCWC-02-Map	M-163		Shanley Spring; B-29-10 28DAA			Grand Canyon - West	Regional	Spring					35.8806	-113.35778	No	Grand Canyon Wildlands Council 2002	
1068	NWIS-2	361524112420400		Fern Spring; B-33-04 11 UNSURVEYED			Havasu Creek	Regional	Spring	Redwall Ls				36.25664897	-112.7018576	Yes	USGS 2010b	
1069	NWIS-2	361303112411200	1	Havasu Spring; B-33-04 26 UNSURVEYED			Havasu Creek	Regional	Spring	Redwall Ls				36.21748238	-112.6874123	Yes	USGS 2010b	
1069	M&A-93b	HS	2	Havasu Spring			Havasu Creek	Regional	Spring	Redwall-Muav Aquifer				36.216944	-112.686111	Yes	M&A 1993b	Laboratory Tested By Tma
1070	GWSI-1	361716111574501	1	At Last Spring; A-33-04 03B			Kaibab Plateau	Regional	Spring	Muav Ls	Perennial	Tubular Cave		36.287761971	-111.96322275	Yes	ADWR 2009b	
1070	NWIS-2	361716111574501	2	A-33-04 03B UNSURVEYED			Kaibab Plateau	Regional	Spring	Muav Ls				36.28776175	-111.9632228	No	USGS 2010b	
1071	GWSI-1	360745111411001	1	03 079-10.39X08.30			Little Col. River	Regional	Spring	Redwall Ls		Fracture		36.129154907	-111.686819359	No	ADWR 2009b	
1071	NWIS-2	360745111411001	2	03 079-10.39X08.30			Little Col. River	Regional	Spring	Redwall Ls				36.12915458	-111.6868195	Yes	USGS 2010b	
1072	GWSI-1	360629111411201	1	03 079-10.42X09.78			Little Col. River	Regional	Spring	Redwall Ls		Fracture		36.108044063	-111.687375042	No	ADWR 2009b	
1072	NWIS-2	360629111411201	2	03 079-10.42X09.78			Little Col. River	Regional	Spring	Redwall Ls				36.1080436	-111.6873747	Yes	USGS 2010b	
1073	GWSI-1	360710111412901	1	03 079-10.69X08.97			Little Col. River	Regional	Spring	Redwall Ls		Fracture		36.119431922	-111.692097442	No	ADWR 2009b	
1073	NWIS-2	360710111412901	2	03 079-10.69X08.97			Little Col. River	Regional	Spring	Redwall Ls				36.11943237	-111.6920973	Yes	USGS 2010b	
1074	GWSI-1	360707111413301	1	03 079-10.78X09.05			Little Col. River	Regional	Spring	Redwall Ls		Fracture		36.118598915	-111.69320848	No	ADWR 2009b	
1074	NWIS-2	360707111413301	2	03 079-10.78X09.05			Little Col. River	Regional	Spring	Redwall Ls				36.118599	-111.6932085	Yes	USGS 2010b	
1075	GWSI-1	360703111413801	1	03 079-10.81X09.10; GC-9			Little Col. River	Regional	Spring	Redwall Ls	Perennial	Fracture		36.117487905	-111.694597525	No	ADWR 2009b	
1075	NWIS-2	360703111413801	2	03 079-10.81X09.10			Little Col. River	Regional	Spring	Redwall Ls				36.1174879	-111.6945974	No	USGS 2010b	
1076	GWSI-1	360700111413701	1	Blue Spring; 03 079-10.81X09.20			Little Col. River	Regional	Spring	Redwall Ls	Perennial	Fracture		36.116654919	-111.694319499	No	ADWR 2009b	
1076	M&A-93b	BS	2	Blue Spring			Little Col. River	Regional	Spring	Redwall-Muav Aquifer				36.116944	-111.692778	Yes	M&A 1993b	
1076	NWIS-2	360700111413701	3	03 079-10.81X09.20			Little Col. River	Regional	Spring	Redwall Ls				36.11665458	-111.6943196	Yes	USGS 2010b	
1077	GWSI-1	361048111421801	1	03 079-11.49X04.86			Little Col. River	Regional	Spring	Redwall Ls		Fracture		36.179987335	-111.705710045	Yes	ADWR 2009b	
1077	NWIS-2	361048111421801	2	03 079-11.49X04.86			Little Col. River	Regional	Spring	Redwall Ls				36.17998734	-111.70571	No	USGS 2010b	
1078	GWSI-1	361119111422101	1	03 079-11.50X04.22			Little Col. River	Regional	Spring	Redwall Ls				36.188598267	-111.706543223	Yes	ADWR 2009b	
1078	NWIS-2	361119111422101	2	03 079-11.50X04.22			Little Col. River	Regional	Spring	Redwall Ls				36.18859838	-111.7065436	No	USGS 2010b	
1079	GWSI-1	361112111430001	1	GC-18 ; 03 079-12.12X04.38			Little Col. River	Regional	Spring	Muav Ls	Perennial	Fracture		36.186654178	-111.717377685	No	ADWR 2009b	
1079	NWIS-2	361112111430001	2	03 079-12.12X04.38			Little Col. River	Regional	Spring	Muav Ls				36.18665385	-111.7173774	No	USGS 2010b	
1080	GWSI-1	361113111434001	1	GC-19,20,21; 03 079-12.75X04.30			Little Col. River	Regional	Spring	Muav Ls		Fracture		36.186931074	-111.728489196	No	ADWR 2009b	
1080	NWIS-2	361113111434001	2	03 079-12.75X04.30			Little Col. River	Regional	Spring	Muav Ls				36.1869315	-111.728489	No	USGS 2010b	
1081	GWSI-1	361119111435201	1	03 079-12.93X04.23			Little Col. River	Regional	Spring	Muav Ls				36.188598036	-111.731822375	No	ADWR 2009b	
1081	NWIS-2	361119111435201	2	03 079-12.93X04.23			Little Col. River	Regional	Spring	Muav Ls				36.18859815	-111.7318225	No	USGS 2010b	
1082	GWSI-1	361129111440701	1	03 079-13.11X04.05			Little Col. River	Regional	Spring	Muav Ls				36.191375979	-111.73598961	No	ADWR 2009b	
1082	NWIS-2	361129111440701	2	03 079-13.11X04.05			Little Col. River	Regional	Spring	Muav Ls				36.19137587	-111.7359894	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1083	ONWI-85	Spr08		Little Colorado River; 4.5 miles up from mouth; North bank			Little Col. River	Regional	Spring	Bright Angel Sh				36.1934945919	-111.739428957	Yes	Woodward-Clyde Consultants 1985	Sampling Site Located in Marble Platform; Water Samples Collected from Observable Springs in The Redwall Limestone at River Level; Located on The North Bank of The Little Colorado River in Bright Angel Shale; Samples Considered Representative of in Situ C
1084	GWSI-1	361535111492001	1	03 062-04.05X16.52			Marble Canyon	Regional	Spring	Bright Angle Sh	Perennial	Fracture		36.259707611	-111.822938403	Yes	ADWR 2009b	
1084	NWIS-2	361535111492001	2	03 062-04.05X16.52			Marble Canyon	Regional	Spring	Bright Angel Sh				36.2597078	-111.8229386	Yes	USGS 2010b	
1085	Taylor-04	BERTS-CAN	1	Berts Canyon			Marble Canyon	Regional	Spring	Muav Ls				36.3980194196	-111.8858468002	Yes	Taylor et al. 2004	Reported Location Utm (420561,4028259)
1085	NWIS-2	362354111530701	2	A-35-05 32D UNSURVEYED			Marble Canyon	Regional	Spring					36.39831885	-111.8859989	No	USGS 2010b	
1085	GCNP-1	LOPE001	3	Loper Spring			Marble Canyon	Regional	Spring					36.3975	-111.8869443	Yes	Grand Canyon National Park 2010a	
1086	SIR-2010-5025	362434111533601	1	Buck Farm Spring; A-35-05 29			Marble Canyon	Regional	Spring					36.409444	-111.893333	Yes	Bills et al. 2010	East Segregation/House Rock Springs - Marble Canyon Reach of The Colorado River Corridor, No Uranium Mines, Breccia Pipes Present
1086	GCNP-1	BUCK002	2	Buck Farm			Marble Canyon	Regional	Spring					36.409685498	-111.893617953	No	Grand Canyon National Park 2010a	
1086	NWIS-1	362434111533601	3				Marble Canyon	Regional	Spring					36.40944444	-111.89333333	Yes	USGS 2009a	
1087	GCNP-1	COLO055		50-mile (Hackberry) Spring	50R		Marble Canyon	Regional	Spring	Bright Angel Sh				36.335	-111.8611111	Yes	Grand Canyon National Park 2010a	
1088	GCNP-1	NANK003		Nankoweap 1-mile Spring			Marble Canyon	Regional	Spring	Muav LS				36.2972222	-111.8763888	Yes	Grand Canyon National Park 2010a	
1089	Taylor-04	SADDLE-CAN		Saddle Canyon			Marble Canyon	Regional	Spring	Muav Ls				36.3597455581	-111.9044271517	Yes	Taylor et al. 2004	Reported Location Utm (418855,4024029)
1090	GCWC-02	GCNP-103		Buck Farm; A-35-05 29B			Marble Canyon	Regional	Spring	Temple Butte Ls - Muav Ls	Perennial	Contact		36.40572	-111.87918	Yes	Grand Canyon Wildlands Council 2002	in Buck Farm Canyon 4Th of 7 Seeps, Approximately 0.5 Miles from The Colorado River at River Mile 40.9
1091	GCWC-02	GCNP-106		Nankoweap I mile; A-34-05 33C			Marble Canyon	Regional	Spring	Muav Ls	Perennial	Contact		36.29313	-111.87947	Yes	Grand Canyon Wildlands Council 2002	South Side of Nankoweap Canyon, Approximately 1 Mile from The Colorado River at River Mile 52
1092	GCWC-02	GCNP-104		Saddle Canyon; A-34-05 07A			Marble Canyon	Regional	Spring	Muav Ls	Perennial	Fracture		36.37831	-111.89056	Yes	Grand Canyon Wildlands Council 2002	in Saddle Canyon, Approximately 0.75 Miles from The Colorado River at River Mile 47.1
1093	GWSI-1	353444113254901	1	Peach Springs No. 1; B-25-11 02CBC			Peach Springs, AZ	Regional	Spring					35.578880265	-113.431046911	Yes	ADWR 2009b	
1093	NWIS-2	353444113254901	2	B-25-11 02CBC			Peach Springs, AZ	Regional	Spring					35.57888015	-113.4310467	Yes	USGS 2010b	
1093	Wenrich-94	2A-W82	3	Peach Springs			Peach Springs, AZ	Regional	Spring	Muav Ls				35.578324572	-113.431046712	Yes	Wenrich et al. 1994	
1094	GWSI-1	353444113255101	1	Peach Springs No. 2; B-25-11 03DAD			Peach Springs, AZ	Regional	Spring					35.578880258	-113.431601934	No	ADWR 2009b	
1094	NWIS-2	353445113255000	2	Peach Spring; B-25-11 03DAA			Peach Springs, AZ	Regional	Spring	Sedimentary Rocks				35.5791579	-113.4313245	Yes	USGS 2010b	
1095	GWSI-1	353109113240201	1	Surprise Springs; B-25-11 25DBD			Peach Springs, AZ	Regional	Spring		Perennial	Tubular Cave		35.51915956	-113.401323749	Yes	ADWR 2009b	
1095	NWIS-2	353109113240201	2	B-25-11 25DBD			Peach Springs, AZ	Regional	Spring	Redwall Ls				35.51888145	-113.4018789	Yes	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1095	Wenrich-94	31A+B-W82	3	Surprise Springs			Peach Springs, AZ	Regional	Spring	Redwall Ls				35.518603663	-113.401878873	Yes	Wenrich et al. 1994	
1095	NURE	23017	4				Peach Springs, AZ	Regional	Spring					35.518492561	-113.402567803	Yes	USGS 2009b	
1096	Wenrich-94	72A-W82	1	Metuck Springs; B-26-10 07DCD			Peach Springs, AZ	Regional	Spring	Muav Ls				35.646657044	-113.383266919	Yes	Wenrich et al. 1994	
1096	NWIS-2	353848113225700	2	B-26-10 07DCD			Peach Springs, AZ	Regional	Spring	Sedimentary Rocks				35.646657	-113.3832669	Yes	USGS 2010b	
1097	NWIS-2	353643113241000	1	Mulberry Spring; B-26-11 25ACB			Peach Springs, AZ	Regional	Spring	Muav Ls				35.61193528	-113.4035455	Yes	USGS 2010b	
1097	Wenrich-94	7A-W82	2	Mulberry Spring			Peach Springs, AZ	Regional	Spring	Muav Ls				35.611657544	-113.403267733	Yes	Wenrich et al. 1994	
1098	GWSI-1	353333113251801	1	Red Spring; B-25-11 14BAA			Peach Springs, AZ	Regional	Spring					35.559158683	-113.422435591	Yes	ADWR 2009b	
1098	Wenrich-94	1A-W82	2	Red Spring			Peach Springs, AZ	Regional	Spring	Muav Ls				35.558602791	-113.422990816	Yes	Wenrich et al. 1994	
1098	NURE	23019	3				Peach Springs, AZ	Regional	Spring					35.558691693	-113.422468594	Yes	USGS 2009b	
1099	GWSI-1	353532113262101	1	Lower Peach Springs; B-26-11 34DBC			Peach Springs, AZ	Regional	Spring					35.592212949	-113.439936246	Yes	ADWR 2009b	
1099	Wenrich-94	3A-W82	2	Lower Peach Springs			Peach Springs, AZ	Regional	Spring	Muav Ls				35.591935357	-113.440213658	Yes	Wenrich et al. 1994	
1099	NURE	23029	3				Peach Springs, AZ	Regional	Spring					35.592590945	-113.44006925	Yes	USGS 2009b	
1100	GWSI-1	354014113251601		Mesquite Spring; B-26-11 02ACB			Peach Springs, AZ	Regional	Spring					35.670545622	-113.421879376	Yes	ADWR 2009b	
1101	Wenrich-94	6A-W82		Mesquite Spring; Bright Angel Shale in landslide block adjacent to Hurricane Fault			Peach Springs, AZ	Regional	Spring	Bright Angel Sh				35.670267429	-113.421879476	Yes	Wenrich et al. 1994	
1102	GCNP-1	BRIG003		Emmett Spring at Old Bright Angel Trail			Grand Canyon - North Rim	Regional	Spring stream					36.210593969	-112.024253868	Yes	Grand Canyon National Park 2010a	
1103	NWIS-2	355308113182600	1	Three Springs Canyon above the Mouth Spring; B-29-10 25 UNSURVEYED			Grand Canyon - West	Regional	Spring stream	Muav Ls				35.88554246	-113.3079867	Yes	USGS 2010b	
1103	Taylor-04	THREE-SP	2	Three Springs			Grand Canyon - West	Regional	Spring stream	Muav Ls				35.8884504782	-113.308324088	Yes	Taylor et al. 2004	Reported Location Utm (291641,3973840)
1103	GCNP-1	THRE001	3	Three Springs			Grand Canyon - West	Regional	Spring stream	Tapeats Ss				35.885658024	-113.308119683	Yes	Grand Canyon National Park 2010a	
1103	NURE	43536	4				Grand Canyon - West	Regional	Spring stream					35.88538691	-113.308864507	Yes	USGS 2009b	
1104	Wenrich-94	79A-W82		Hindu Canyon			Grand Canyon - West	Regional	Spring stream	Muav Ls				35.703044438	-113.57966274	Yes	Wenrich et al. 1994	
1105	NWIS-2	354322111254001		A-27-09 15BCC			Cameron, AZ	Regional	Well	Muav Ls			4350	35.72277624	-111.4284792	No	USGS 2010b	
1106	NWIS-2	354240111260701		A-27-09 21ABD			Cameron, AZ	Regional	Well				3624	35.7111099	-111.4359796	No	USGS 2010b	
1107	NWIS-2	353134112094901		A-25-02 27ABA			Coconino Plateau - East	Regional	Well				3670	35.5261123	-112.1643325	Yes	USGS 2010b	
1108	NWIS-2	353930112075001		A-26-02 01CDD			Coconino Plateau - East	Regional	Well	Redwall Ls			3200	35.65832914	-112.1312764	Yes	USGS 2010b	
1109	NWIS-2	353839112083601		A-26-02 11DCD			Coconino Plateau - East	Regional	Well	Redwall Ls			3450	35.64413527	-112.1440823	No	USGS 2010b	
1110	NWIS-2	353843112083301		A-26-02 11DDB			Coconino Plateau - East	Regional	Well				3450	35.6452741	-112.1432211	Yes	USGS 2010b	
1111	NWIS-2	354610112212001		B-28-01 35ACA			Coconino Plateau - East	Regional	Well				3544	35.7683236	-112.3579512	No	USGS 2010b	
1112	NWIS-2	354606112212601		B-28-01 35ACC			Coconino Plateau - East	Regional	Well	Redwall Ls			3544	35.7683236	-112.3579512	No	USGS 2010b	
1113	NWIS-2	354749113043901		B-28-08 24DAA1			Coconino Plateau - West	Regional	Well				3217	35.79693267	-113.0782567	No	USGS 2010b	
1114	NWIS-2	355530113214001		B-29-01 02CAD			Grand Canyon - West	Regional	Well				1059	35.92498638	-113.3618772	No	USGS 2010b	
1115	NWIS-2	360823112394801		B-32-04 24CDA1			Havasu Creek	Regional	Well	Redwall Ls			3000	36.13970506	-112.6640776	No	USGS 2010b	
1116	NWIS-2	360823112394802		B-32-04 24CDA2			Havasu Creek	Regional	Well	Redwall Ls			3100	36.13970506	-112.6640776	Yes	USGS 2010b	
1117	NWIS-2	361808111305001		03 061-00.76X13.63			Painted Desert	Regional	Well	Redwall Ls			3440	36.3022106	-111.5145923	No	USGS 2010b	
1118	NWIS-2	353050113070001		B-25-08 34AA			Peach Springs, AZ	Regional	Well	Muav Ls			1943	35.51388326	-113.117421	No	USGS 2010b	
1119	NWIS-2	353120113120001		B-25-09 26DBC			Peach Springs, AZ	Regional	Well	Muav Ls			1700	35.5191604	-113.2085369	No	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1120	Wenrich-94	48A-W82	1	Shipley Well; B-25-10 29BBD1			Peach Springs, AZ	Regional	Well	Muav Ls				35.526381491	-113.374655496	Yes	Wenrich et al. 1994	
1120	NWIS-2	353135113222601	2	B-25-10 29BBD1			Peach Springs, AZ	Regional	Well					35.52638148	-113.3746555	No	USGS 2010b	
1121	NWIS-2	370125113190001		C-43-13 28AB1			Virgin River Valley	Regional	Well				3000	37.0235948	-113.3174488	No	USGS 2010b	
1122	NWIS-2	360932111512001	1	Moonshine Spring; A-32-05 16A UNSURVEYED			Grand Canyon - East	Below regional	Spring					36.15887434	-111.8562718	No	USGS 2010b	
1122	GCNP-1	LAVA004	2	Moonshine Spring			Grand Canyon - East	Below regional	Spring					36.159233336	-111.853750005	Yes	Grand Canyon National Park 2010a	
1123	GCNP-1	COLO117		117-mile Spring	117L		Grand Canyon - East	Below regional	Spring	Tapeats Ss				36.201707132	-112.457088556	Yes	Grand Canyon National Park 2010a	
1124	GCNP-1	UNKA002		Unkar (Ambush) Spring			Grand Canyon - East	Below regional	Spring	Dox Ss				36.094390035	-111.89559985	Yes	Grand Canyon National Park 2010a	
1125	GCWC-02	GCNP-107		Dead Duck; A-31-05 03C			Grand Canyon - East	Below regional	Spring	Dox Fm	Perennial	Contact; Fracture		36.09503	-111.84681	Yes	Grand Canyon Wildlands Council 2002	Colorado River Mile 70, Right Site at 20 Meters from River
1126	NWIS-2	354815113192000		222 Mile Canyon Springs	222		Grand Canyon - West	Below regional	Spring	Granite				35.80415479	-113.322987	Yes	USGS 2010b	
1127	NWIS-2	354522113264800	1	Travertine Falls Spring; B-27-11 03 UNSURVEYED			Grand Canyon - West	Below regional	Spring	Tapeats Ss				35.756099	-113.4474358	Yes	USGS 2010b	
1127	Wenrich-94	18A-W82	2	Travertine Falls Spring			Grand Canyon - West	Below regional	Spring	Granite				35.755821198	-113.44771353	Yes	Wenrich et al. 1994	
1128	NWIS-2	355502113195901		B-29-10 14 1 UNSURVEYED			Grand Canyon - West	Below regional	Spring	Tapeats Ss				35.91720866	-113.3338208	No	USGS 2010b	
1129	NWIS-2	355502113195900		Pumpkin Spring at River Mile 213; B-29-10 14 2 UNSURVEYED	213		Grand Canyon - West	Below regional	Spring	Tapeats Ss				35.91720866	-113.3338208	Yes	USGS 2010b	
1130	Wenrich-94	67A-W82		Robbers Roost Spring			Grand Canyon - West	Below regional	Spring	Vishnu Schist				35.718045316	-113.296319334	Yes	Wenrich et al. 1994	
1131	NWIS-2	355459113195900	1	River Mile 212.9, GCNP: Pumpkin Spring	212.9		Grand Canyon - West	Below regional	Spring					35.91637534	-113.3338208	Yes	USGS 2010b	
1131	GCNP-1	COLO002	2	Pumpkin Spring			Grand Canyon - West	Below regional	Spring	Tapeats Ss/ Travertine				35.916133335	-113.334216662	No	Grand Canyon National Park 2010a	
1131	Peterson-77	CF-16	3	Pumpkin Spring; River Mile 212.9	212.9		Grand Canyon - West	Below regional	Spring	Tapeats Ss				35.916375354	-113.333820892	Yes	Peterson et al. 1977	
1131	Wenrich-94	77A-W82	4	Pumpkin Spring			Grand Canyon - West	Below regional	Spring	Tapeats Ss				35.916653149	-113.33270966	Yes	Wenrich et al. 1994	
1131	Taylor-04	PUMPKIN-SP	5	Pumpkin Spring			Grand Canyon - West	Below regional	Spring	Tapeats Ss				35.8851120931	-113.3070863045	Yes	Taylor et al. 2004	Reported Location Utm (291744,3973467)
1132	NWIS-2	354503113252600	1	Travertine Canyon abv mouth at River Mile 228	228		Grand Canyon - West	Below regional	Spring					35.75082145	-113.4246572	Yes	USGS 2010b	
1132	Wenrich-94	17A-W82	2	Travertine Falls			Grand Canyon - West	Below regional	Spring	Vishnu Schist				35.750543715	-113.425768374	Yes	Wenrich et al. 1994	
1133	GCNP-1	COLO206		205.8-mile (Orchid) Spring	205.8R		Grand Canyon - West	Below regional	Spring					36.000259783	-113.340607632	Yes	Grand Canyon National Park 2010a	
1134	NURE	23028					Grand Canyon - West	Below regional	Spring					35.761788477	-113.362266139	Yes	USGS 2009b	
1135	Wenrich-94	21A-W82		Seep south of Separation Canyon			Grand Canyon - West	Below regional	Spring	Granite				35.807765549	-113.566884352	Yes	Wenrich et al. 1994	
1136	Wenrich-94	22A-W82		Seep south of Separation Canyon			Grand Canyon - West	Below regional	Spring	Granite				35.807765556	-113.567717684	Yes	Wenrich et al. 1994	
1137	Taylor-04	NANK-TWIN-SP		Nankoweap Twin Spring			Marble Canyon	Below regional	Spring	Quartzite/schist				36.2817077983	-111.8889287016	Yes	Taylor et al. 2004	Reported Location Utm (420166,4015360)

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1138	GCWC-02	GCNP-105		Butte Fault upper; A-33-05 05C			Marble Canyon	Below regional	Spring		Perennial	Fracture; Fault		36.28231	-111.89014	Yes	Grand Canyon Wildlands Council 2002	in Nankoweap Canyon, Approximately 2.5 Miles from The Colorado River at River Mile 52, 30 Meters from Gcnp105A
1139	GCWC-02	GCNP-105a		Butte Fault lower; A-33-05 05C			Marble Canyon	Below regional	Spring		Perennial	Fracture; Fault		36.28231	-111.89014	Yes	Grand Canyon Wildlands Council 2002	in Nankoweap Canyon, Approximately 2.5 Miles from The Colorado River at River Mile 52, 30 Meters from Gcnp105
1140	GCNP-1	ROAR002		Roaring Springs below pumphouse			Grand Canyon - North Rim	Below regional	Spring stream	Tapeats Ss				36.192647745	-112.032294806	Yes	Grand Canyon National Park 2010a	
1141	GCNP-1	ROAR003		Roaring Springs above main springs			Grand Canyon - North Rim	Below regional	Spring stream	Bright Angel Sh				36.194852381	-112.036939481	Yes	Grand Canyon National Park 2010a	
1142	Wenrich-94	19A-W82		Lost Travertine Falls Spring			Grand Canyon - West	Below regional	Spring stream	Tapeats Ss				35.756098609	-113.498270898	Yes	Wenrich et al. 1994	
1143	Wenrich-94	20A-W82		1/4 mile below Bridge Canyon Spring			Grand Canyon - West	Below regional	Spring stream	Vishnu Schist/ granite				35.769154336	-113.527160796	Yes	Wenrich et al. 1994	
1144	NWIS-2	09401200		Little Colorado River at Cameron, AZ			Cameron, AZ	N/A	Stream	N/A	Intermittent			35.8777729	-111.4118096	Yes	USGS 2010b	
1145	NWIS-2	09403850	1	Kanab Creek above mouth near Supai, AZ			Grand Canyon - Central	N/A	Stream					36.39581624	-112.6318566	Yes	USGS 2010b	
1145	GCNP-1	KANA002	2	Kanab Creek Below old USGS Site			Grand Canyon - Central	N/A	Stream					36.3947222	-112.6325	Yes	Grand Canyon National Park 2010a	
1146	NWIS-2	361518112523900	1	National Canyon above mouth at River Mile 166.5 in Hualapai	166.5		Grand Canyon - Central	N/A	Stream	N/A				36.2549818	-112.8782527	No	USGS 2010b	
1146	NWIS-1	361518112523900	2	National Canyon above mouth at River Mile 166.5 in Hualapai	166.5		Grand Canyon - Central	N/A	Stream	N/A				36.2549818	-112.87825272	Yes	USGS 2009a	
1147	GCNP-1	140M001		140 Mile Canyon	140L		Grand Canyon - Central	N/A	Stream					36.3983333	-112.5683333	Yes	Grand Canyon National Park 2010a	
1148	GCNP-1	DEER001		Deer Creek Below Main Falls			Grand Canyon - Central	N/A	Stream					36.3886111	-112.5083333	Yes	Grand Canyon National Park 2010a	
1149	GCNP-1	DEER002		Deer Creek Patio			Grand Canyon - Central	N/A	Stream	Bright Angel Sh				36.392244048	-112.506172694	Yes	Grand Canyon National Park 2010a	
1150	GCNP-1	DEER006		Deer Creek below middle confluence			Grand Canyon - Central	N/A	Stream					36.3975	-112.5052778	Yes	Grand Canyon National Park 2010a	
1151	GCNP-1	MATK001		Matkatamiba near River	148.5L		Grand Canyon - Central	N/A	Stream					36.3422222	-112.6719444	Yes	Grand Canyon National Park 2010a	
1152	GCNP-1	OLO001		Olo Canyon at Waterfall	146R		Grand Canyon - Central	N/A	Stream					36.3705555	-112.6497222	Yes	Grand Canyon National Park 2010a	
1153	GCNP-1	STON003		Stone Creek near River below Falls			Grand Canyon - Central	N/A	Stream					36.347494717	-112.452453529	Yes	Grand Canyon National Park 2010a	
1154	GCNP-1	TAPE001		Tapeats Creek near River			Grand Canyon - Central	N/A	Stream	Alluvium				36.371255723	-112.468749603	Yes	Grand Canyon National Park 2010a	
1155	GCNP-1	TAPE002		Tapeats above Thunder			Grand Canyon - Central	N/A	Stream					36.3933333	-112.4511111	Yes	Grand Canyon National Park 2010a	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1156	GCNP-1	TAPE003		Tapeats below Thunder			Grand Canyon - Central	N/A	Stream					36.3905556	-112.4525	Yes	Grand Canyon National Park 2010a	
1157	Taylor-96	HAVA-MO		Havasu Creek near mouth			Grand Canyon - Central	N/A	Stream					36.3140881049	-112.760158682	Yes	Taylor et al. 1996	Reported Location River Kilometer 252.3
1158	NWIS-2	09403000		Bright Angel Creek near Grand Canyon, AZ			Grand Canyon - East	N/A	Stream					36.10303836	-112.0962798	Yes	USGS 2010b	
1159	STORET-1	GRCA_FIT_ BRIG02	1	Bright Angel Creek at mouth			Grand Canyon - East	N/A	Stream					36.0997222	-112.0938889	No	USEPA 2010	Bright Angel Creek is Located on The North Rim Within The Boundary of Grand Canyon National Park in The Bright Angel Creek Drainage, Downstream of Phantom Ranch.
1159	Fitz-96	BRIG	2	Bright Angel Creek (North Rim)			Grand Canyon - East	N/A	Stream		Perennial			36.0997222	-112.0938889	Yes	Fitzgerald 1996	
1159	Taylor-96	BRIG-MO	3	Bright Angel Creek near mouth			Grand Canyon - East	N/A	Stream					36.1013710665	-112.087131007	Yes	Taylor et al. 1996	Reported Location River Kilometer 141.5
1160	GCNP-1	CLEA001		Clear Creek near River			Grand Canyon - East	N/A	Stream					36.082359249	-112.035948853	Yes	Grand Canyon National Park 2010a	
1161	GCNP-1	CRYS001		Crystal near River			Grand Canyon - East	N/A	Stream	Alluvium				36.135516398	-112.244018568	Yes	Grand Canyon National Park 2010a	
1162	GCNP-1	SHIN001		Shinimo Creek near River			Grand Canyon - East	N/A	Stream					36.2372222	-112.3488889	Yes	Grand Canyon National Park 2010a	
1163	GCNP-1	SHIN002		Shinimo Creek at Trail Xing			Grand Canyon - East	N/A	Stream	Hakatai Sh/ alluvium				36.241096307	-112.349969132	Yes	Grand Canyon National Park 2010a	
1164	GCNP-1	SHIN003		Shinimo Creek Above Burro Canyon			Grand Canyon - East	N/A	Stream	Hakatai Sh/ alluvium				36.244306449	-112.348293806	Yes	Grand Canyon National Park 2010a	
1165	GCNP-1	SHIN004		Shinumo Creek at WQ reference site			Grand Canyon - East	N/A	Stream	PC meta/ig				36.238868785	-112.349246447	Yes	Grand Canyon National Park 2010a	
1166	GCNP-1	BRIG006		Bright Angel Creek above Roaring confluence			Grand Canyon - North Rim	N/A	Stream	Tapeats Ss				36.1933333	-112.0319444	Yes	Grand Canyon National Park 2010a	
1167	GCNP-1	BRIG007		Phantom Creek at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream	PC meta/ign.				36.1163888	-112.0875	Yes	Grand Canyon National Park 2010a	
1168	GCNP-1	BRIG008		The Trancept at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream					36.1716666	-112.0402777	Yes	Grand Canyon National Park 2010a	
1169	GCNP-1	PHAN002		Haunted Creek at Phantom Creek confluence			Grand Canyon - North Rim	N/A	Stream	Channel alluvium				36.144764668	-112.120888122	Yes	Grand Canyon National Park 2010a	
1170	GCNP-1	PHAN003		Phantom Creek at Haunted Creek Confluence			Grand Canyon - North Rim	N/A	Stream	Channel alluvium				36.144887015	-112.121301121	Yes	Grand Canyon National Park 2010a	
1171	GCNP-1	RIBB001		Ribbon Falls below lower falls			Grand Canyon - North Rim	N/A	Stream	Shinumo Qtzite				36.1591667	-112.0552778	Yes	Grand Canyon National Park 2010a	
1172	GCNP-1	WALL001		Wall Creek at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream	Shinumo Qtzite				36.163523415	-112.046388172	Yes	Grand Canyon National Park 2010a	
1173	NWIS-2	09404200		Colorado River above Diamond Creek near Peach Spring			Grand Canyon - West	N/A	Stream	N/A	Perennial			35.7735994	-113.363544	Yes	USGS 2010b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1174	GCNP-1	SPRI001		Spring Canyon			Grand Canyon - West	N/A	Stream					36.0186111	-113.3519444	Yes	Grand Canyon National Park 2010a	
1175	GCNP-1	SPRI002		Spring Canyon			Grand Canyon - West	N/A	Stream					36.018337153	-113.353235966	Yes	Grand Canyon National Park 2010a	
1176	NURE	43538					Grand Canyon - West	N/A	Stream					35.7455882	-113.425968391	Yes	USGS 2009b	
1177	NURE	43540					Grand Canyon - West	N/A	Stream					35.772487594	-113.524071767	Yes	USGS 2009b	
1178	Wenrich-94	23A-W82		Mouth of Spencer Canyon; Spencer Canyon gravels			Grand Canyon - West	N/A	Stream	Alluvium?				35.823320973	-113.567717638	Yes	Wenrich et al. 1994	
1179	NWIS-1	361308112413001		Sample point #25 Havasu Creek near Supai, AZ			Havasu Creek	N/A	Stream					36.21887129	-112.69241252	Yes	USGS 2009a	
1180	NURE	GCBH032R					Kaibab Plateau	N/A	Stream	KBBL Carbonate				36.510385145	-112.136130069	Yes	USGS 2009b	
1181	EFN-88b	SW-KC7	1	Kanab Creek at confluence with Colorado River			Kanab Creek - Lower	N/A	Stream					36.39214	-112.62961	Yes	Energy Fuels Nuclear 1988b	
1181	GCNP-1	KANA001	2	Kanab Creek at confluence with Colorado River			Kanab Creek - Lower	N/A	Stream					36.3922222	-112.6294443	Yes	Grand Canyon National Park 2010a	
1181	Taylor-96	KANA-MO	3	Kanab Creek near mouth			Kanab Creek - Lower	N/A	Stream					36.3917926917	-112.618411291	Yes	Taylor et al. 1996	Reported Location River Kilometer 230.7
1182	NWIS-2	09402300		Little Colorado Rver above mouth near Desert View, AZ			Little Col. River	N/A	Stream					36.1952642	-111.7771024	Yes	USGS 2010b	
1183	NWIS-2	361133111474500	1	River Mile 0.1, Little Colorado River			Little Col. River	N/A	Stream					36.19248619	-111.7965476	Yes	USGS 2010b	
1183	Taylor-96	LCOL-MO	2	Little Colorado River near mouth			Little Col. River	N/A	Stream					36.2010188935	-111.80024413	Yes	Taylor et al. 1996	Reported Location River Kilometer 98.5
1184	NWIS-2	361203111452501		River Mile 3.1, Little Colorado River			Little Col. River	N/A	Stream					36.20082	-111.7576572	Yes	USGS 2010b	
1185	NWIS-2	361817111513200	1	Nankoweap Creek 100 met from mouth of Col River, AZ			Marble Canyon	N/A	Stream					36.30470756	-111.8596075	Yes	USGS 2010b	
1185	GCNP-1	NANK001	2	Nankoweap Creek near River			Marble Canyon	N/A	Stream	Alluvium				36.3047222	-111.8616667	Yes	Grand Canyon National Park 2010a	
1186	GCNP-1	SADD002		Saddle Canyon	47.5R		Marble Canyon	N/A	Stream					36.3597222	-111.905	Yes	Grand Canyon National Park 2010a	
1187	NWIS-2	355228111202101		03 98-05.03X08.25			Cameron, AZ	N/D	Well					35.87443979	-111.3398643	Yes	USGS 2010b	
1188	NWIS-2	355016111213001		A-28-10 05BCC1			Cameron, AZ	N/D	Well					35.8377737	-111.3590319	No	USGS 2010b	
1189	NWIS-2	355421111240101		JDD-1			Cameron, AZ	N/D	Well					35.90582797	-111.4009757	Yes	USGS 2010b	
1190	NWIS-2	353210112163001		A-25-01 22BD			Coconino Plateau - East	N/D	Well					35.53611178	-112.2757247	No	USGS 2010b	
1191	NWIS-2	353906112115101		A-26-02 08ACA			Coconino Plateau - East	N/D	Well					35.6516627	-112.1982227	No	USGS 2010b	
1192	NURE	23089					Coconino Plateau - East	N/D	Well					35.806188656	-112.436232269	Yes	USGS 2009b	
1193	NWIS-2	355744113002601		B-18-07 09AAB			Coconino Plateau - West	N/D	Well					35.96220626	-113.007977	No	USGS 2010b	
1194	NWIS-2	354020113025001		B-26-07 05AB			Coconino Plateau - West	N/D	Well					35.6722133	-113.0479762	No	USGS 2010b	
1195	NWIS-2	354438112523301		B-27-06 12BDB			Coconino Plateau - West	N/D	Well					35.74387846	-112.8765822	Yes	USGS 2010b	
1196	NWIS-2	354238113020901		B-27-07 21CBA			Coconino Plateau - West	N/D	Well					35.71054574	-113.0365877	No	USGS 2010b	
1197	NWIS-2	354117113020801		B-27-07 21CCA1			Coconino Plateau - West	N/D	Well				490	35.68804627	-113.0363094	No	USGS 2010b	
1198	NWIS-2	354117113020802		B-27-07 21CCA2			Coconino Plateau - West	N/D	Well				494	35.68804627	-113.0363094	No	USGS 2010b	
1199	NWIS-2	354650113042601		B-28-07 30CBC			Coconino Plateau - West	N/D	Well				150	35.78054415	-113.0746454	No	USGS 2010b	
1200	NWIS-2	354710113042801	1	B-28-07 31CBB			Coconino Plateau - West	N/D	Well				150	35.7680444	-113.0752009	No	USGS 2010b	
1200	NURE	23022	2				Coconino Plateau - West	N/D	Well					35.76798888	-113.074856468	Yes	USGS 2009b	
1201	NWIS-2	354552113042301		B-28-07 31CCA			Coconino Plateau - West	N/D	Well					35.7644334	-113.073812	No	USGS 2010b	
1202	NWIS-2	354638113065701		B-28-08 27DDC			Coconino Plateau - West	N/D	Well					35.77721097	-113.1165912	No	USGS 2010b	
1203	NURE	23023					Coconino Plateau - West	N/D	Well					35.7054903	-113.036754223	Yes	USGS 2009b	
1204	NURE	23079					Coconino Plateau - West	N/D	Well					35.624394252	-112.621736592	Yes	USGS 2009b	

Table F-1. Site Information for Water Quality Samples (Continued)

Project Site ID	Record Source[1]	Record Source Site ID[1]	Record Rank[2]	Site Description	Colorado River Mile	Parcel	Area	Aquifer Type	Site Type	Site Geology	Permanency	Spring Description	Well Depth (feet)	Latitude	Longitude	Sample Data	Reference	Comments
1205	NURE	23080					Coconino Plateau - West	N/D	Well					35.742389614	-112.875148731	Yes	USGS 2009b	
1206	NURE	23090					Coconino Plateau - West	N/D	Well					35.557096928	-112.597234789	Yes	USGS 2009b	
1207	NURE	23091					Coconino Plateau - West	N/D	Well					35.624394256	-112.620636562	Yes	USGS 2009b	
1208	NWIS-2	364541113221501		B-39-10 21DCB			Hurricane Valley	N/D	Well					36.76137206	-113.3716192	No	USGS 2010b	
1209	NWIS-2	364243112124501		A-38-02 08BBD			Kaibab Plateau	N/D	Well					36.7119346	-112.2132339	No	USGS 2010b	
1210	NWIS-2	364218112122601		A-38-02 08CAD			Kaibab Plateau	N/D	Well					36.7049899	-112.207956	No	USGS 2010b	
1211	NWIS-2	365909112360501		B-41-03 03A 2 UNSURVEYED			Kaibab Paiute Reservation	N/D	Well					36.98581885	-112.602148	No	USGS 2010b	
1212	NWIS-2	365535112460501		Tribe sm irrigation well			Kaibab Paiute Reservation	N/D	Well					36.92637387	-112.768817	Yes[3]	USGS 2010b	
1213	NWIS-2	364205111335001		01-044-03.52X03.33			Kaibito Plateau	N/D	Well				1287	36.70137807	-111.5646007	No	USGS 2010b	
1214	NWIS-2	363410111240001		A-37-09 26D			Kaibito Plateau	N/D	Well				1116	36.56943585	-111.4007048	No	USGS 2010b	
1215	NWIS-2	370125111360801		D-43-03 32DCA2			Lake Powell Vicinity	N/D	Well					37.02359725	-111.6029419	No	USGS 2010b	
1216	NWIS-2	360012111342501		03 079-04.08X16.95			Painted Desert	N/D	Well				412	36.0033241	-111.5743123	No	USGS 2010b	
1217	NWIS-2	353104113185801		B-25-10 26CDA			Peach Springs, AZ	N/D	Well				1652	35.51777088	-113.3168752	Yes	USGS 2010b	
1218	NWIS-2	353134113215501		B-25-10 29ACA			Peach Springs, AZ	N/D	Well				202	35.52610376	-113.366044	No	USGS 2010b	
1219	NWIS-2	353053113192201		B-25-10 35BBB			Peach Springs, AZ	N/D	Well				1043	35.51471534	-113.3235422	No	USGS 2010b	
1220	NWIS-2	353141113251901		B-25-11 26BAA			Peach Springs, AZ	N/D	Well				350	35.5280478	-113.422713	Yes	USGS 2010b	
1221	NWIS-2	353137113252001		B-25-11 26BAD			Peach Springs, AZ	N/D	Well				924	35.5269367	-113.4229909	No	USGS 2010b	
1222	NWIS-2	353044113301701		B-25-12 36ACB			Peach Springs, AZ	N/D	Well				855	35.50999206	-113.5102167	No	USGS 2010b	
1223	NURE	23173					Peach Springs, AZ	N/D	Well					35.514693141	-113.319764217	Yes	USGS 2009b	
1224	NWIS-2	365153113134401		B-40-09 14DBC			Uinkaret Plateau - North	N/D	Well					36.86470668	-113.2296689	No	USGS 2010b	
1225	NWIS-2	365640112542101		B-41-06 23ABD			Uinkaret Plateau - North	N/D	Well					36.94442909	-112.9066003	No	USGS 2010b	
1226	NWIS-2	365645112535301		B-41-06 24BBA			Uinkaret Plateau - North	N/D	Well					36.94581799	-112.8988223	No	USGS 2010b	
1227	NWIS-2	365508113110701		B-41-08 29CDC			Uinkaret Plateau - North	N/D	Well					36.9188733	-113.1860558	No	USGS 2010b	
1228	NWIS-2	365624113132501		B-41-09 24CBA			Uinkaret Plateau - North	N/D	Well					36.93998438	-113.2243908	No	USGS 2010b	
1229	NWIS-2	370221113265101		C-43-14 20ABB2			Virgin River Valley	N/D	Well					37.0391493	-113.4482849	No	USGS 2010b	
1230	NWIS-2	370036113282801		C-43-14 31BBB1			Virgin River Valley	N/D	Well					37.0099826	-113.4752298	Yes	USGS 2010b	
1231	NWIS-2	370404113320301		C-43-15 04DDC1			Virgin River Valley	N/D	Well					37.06775946	-113.5349543	No	USGS 2010b	
1232	NWIS-2	370338113315001		C-43-15 09ADD1			Virgin River Valley	N/D	Well					37.0605373	-113.531343	No	USGS 2010b	
1233	NWIS-2	370201113301701		C-43-15 23BDA1			Virgin River Valley	N/D	Well					37.03359337	-113.5055084	No	USGS 2010b	
1234	NWIS-2	370125113290401		C-43-15 24DCC1			Virgin River Valley	N/D	Well					37.0233158	-113.4832856	No	USGS 2010b	

Notes:

[1] Record source is the database form used in the EIS compilation for the reference shown at the left. The record source identifier is the unique database code that identifies the record within each data source.

[2] Record rank is the order assigned to records from different data sources for the same site feature. The order is typically based on quality of the data and is used for display and analysis in the EIS.

[3] Data not provided in Appendix F.

Abbreviations:

ADWR = Arizona Department of Water Resources
BLM = U.S. Bureau of Land Management
Cen = Central
E = East
EFN = Energy Fuels Nuclear, Inc.
Fitz = Fitzgerald
GRCA = Grand Canyon National Park
GWSI = Groundwater Site Inventory (maintained by ADWR)
ID = Identifier
L = Lower
lat = latitude
long = longitude
M&A = Montgomery & Associates
Mts = Mountains
N = North
N/A = Not applicable
N/D = Not determined
NF = National Forest
NURE = National Uranium Resource Evaluation
NWIS = National Water Information System
ONWI = Office of Nuclear Waste Isolation
Q = Flow Rate
RM = River Mile
SIR = Scientific Investigations Report
TMA = Thermo Analytical, Inc., Richmond, California
USEPA = U.S. Environmental Protection Agency
USGS = U.S. Geological Survey
UTM = Universal Transverse Mercator map projection
W = West
WQ = Water Quality

Site Geology:

BA = Bright Angel
CCNN = Coconino
CHNL = Chinle
Fm = Formation
ig = igneous
KBBL = Kaibab limestone
Ls = Limestone
Mbr = Member
meta = metamorphic
MNKP = Moenkopi
NVJF = Navajo Formation
PC = Precambrian
PRMN = Permian
QTRN = Quaternary
Qtzite = Quartzite
Sh = Shale
Ss = Sandstone
TRSS = Triassic
UNKN = Unknown
U = Upper

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Appendix G

SUMMARY OF SELECTED CHEMICAL QUALITY DATA FOR WATER SAMPLES

Table G-1. Summary of Selected Chemical Quality Data for Water Samples

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1	Trap Spring; B-41-01 07AA	B-41-01 07AA	North	Kanab Plateau - North	Mesozoic	Spring	36.97426	-112.4348	01-Jul-85	01-Jul-85	1690	1690	1690	1				0				0				0	0.1	0.1	0.1	1
3	Bulrush Seeps; B-39-04 14B	B-39-04 14B	North	Kanab Plateau - North	Mesozoic	Spring	36.7843187055	-112.69486883	23-Aug-85	23-Aug-85	576	576	576	1				0				0				0	0.15	0.15	0.15	1
5	Yellowstone Spring; B-39-06 33DCC	B-39-06 33DCC	North	Yellowstone Mesa	Mesozoic	Spring	36.731096453	-112.94326452	15-Aug-51	01-Jul-85				0				0				0				0	0.5	1	0.75	2
6	Yellowstone Spring (source); B-38-06 04AB	B-38-06 04AB	North	Yellowstone Mesa	Mesozoic	Spring	36.72789	-112.94245	13-May-79	13-May-79				0				0				0	31.4	31.4	31.4	1				0
7			North	Yellowstone Mesa	Mesozoic	Spring	36.781685749	-112.846560931	15-May-79	15-May-79				0				0				0	1.585	1.585	1.585	1				0
8	Moonshine Spring; B-39-05 17ADD	B-39-05 17ADD	North	Yellowstone Mesa	Mesozoic	Spring	36.78172	-112.84672	01-Jul-85	01-Jul-85				0				0				0				0	0.5	0.5	0.5	1
12	B-39-05 03ABA	B-39-05 03ABA	North	Antelope Valley	Mesozoic	Well	36.8160967	-112.814927	06-Aug-76	06-Aug-76	760	760	760	1				0				0				0				0
15	B-39-05 04AAC	B-39-05 04AAC	North	Antelope Valley	Mesozoic	Well	36.81498558	-112.8313166	15-May-79	15-May-79				0				0				0	9.038	9.038	9.038	1				0
16	B-39-05 11BBB	B-39-05 11BBB	North	Antelope Valley	Mesozoic	Well	36.8024857	-112.8085375	15-May-79	15-May-79				0				0				0	1.923	1.923	1.923	1				0
18	B-39-05 36ADC	B-39-05 36ADC	North	Antelope Valley	Mesozoic	Well	36.73804157	-112.7754788	11-Aug-76	11-Aug-76	2580	2580	2580	1				0				0				0				0
20	B-41-01 15CBA	B-41-01 15CBA	North	Kanab Plateau - North	Mesozoic	Well	36.95359778	-112.3935288	12-Aug-76	12-Aug-76	6810	6810	6810	1				0				0				0				0
21	Bitter Seeps Well; B-39-03 06AB	B-39-03 06AB	North	Kanab Plateau - South	Mesozoic	Well	36.815722	-112.654495	22-Aug-85	22-Aug-85	3000	3000	3000	1				0				0				0				0
22	Clayhole Well #1 (North); B-38-07 05ACC1	B-38-07 05ACC1	North	Uinkaret Plateau - Central	Mesozoic	Well	36.72442936	-113.0688264	25-Feb-81	25-Feb-81	1105	1105	1105	1				0				0				0				0
23	Clayhole Well #2 (South); B-38-07 05ACC2	B-38-07 05ACC2	North	Uinkaret Plateau - Central	Mesozoic	Well	36.72415158	-113.0691041	19-May-79	25-Feb-81	988	988	988	1				0				0	15.3	15.3	15.3	1				0
25	Old RCA Well; B-38-07 16DDB	B-38-07 16DDB	North	Uinkaret Plateau - Central	Mesozoic	Well	36.6908179	-113.0449355	19-May-79	19-May-79				0				0				0	85.98	85.98	85.98	1				0
28	Black Point Windmill; B-38-07 34CBB	B-38-07 34CBB	North	Uinkaret Plateau - Central	Mesozoic	Well	36.6505396	-113.041323	25-Feb-81	25-Feb-81	1105	1105	1105	1				0				0				0				0
33	B-39-05 18DCB	B-39-05 18DCB	North	Yellowstone Mesa	Mesozoic	Well	36.7760968	-112.8702064	07-Aug-76	07-Aug-76	1070	1070	1070	1				0				0				0				0
34	B-39-06 01DCC	B-39-06 01DCC	North	Yellowstone Mesa	Mesozoic	Well	36.8035966	-112.88993	15-May-79	15-May-79				0				0				0	2.36	2.36	2.36	1				0
35	B-39-06 02AAD	B-39-06 02AAD	North	Yellowstone Mesa	Mesozoic	Well	36.8138743	-112.900764	07-Aug-76	07-Aug-76	327	327	327	1				0				0				0				0
41	Clearwater Spring; B-39-03 21AB	B-39-03 21ABD	North	Kanab Creek - Central	Perched	Spring	36.77161	-112.61696	08-Jun-82	28-Aug-09	1300	2930	2115	2	0.93	0.93	0.93	1	0.06	0.06	0.06	1	1.28	1.28	1.28	1	1.4	5.8	3.6	2
42	Water Canyon Seep #3; B-38-03 05DA	B-38-03 05DA	North	Kanab Creek - Central	Perched	Spring	36.7211389	-112.631242	25-Oct-85	25-Oct-85	1248	1248	1248	1				0				0				0	1.4	1.4	1.4	1
43	Water Canyon Seep #2; B-38-03 05DA	B-38-03 05DA	North	Kanab Creek - Central	Perched	Spring	36.722033	-112.63437	25-Oct-85	25-Oct-85				0				0				0				0	0	0	0	1
44	Upper Water Canyon Spring; B-38-03 05AC	B-38-03 05AC	North	Kanab Creek - Central	Perched	Spring	36.72327	-112.6352	09-Jun-82	25-Oct-85	1235	2900	2067.5	2	2.5	2.5	2.5	1				0	17	17	17	1	0.75	0.75	0.75	1
45	Lower Water Canyon Spring; B-38-03 04CB	B-38-03 04CB	North	Kanab Creek - Central	Perched	Spring	36.72092	-112.62714	08-Jun-82	08-Jun-82	1300	1300	1300	1				0				0				0	0.75	0.75	0.75	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
46	Bessie Spring Lower; B-36-04 24AC	B-36-04 24AC	North	Kanab Creek - Lower	Perched	Spring	36.50661	-112.6755	29-Aug-84	29-Aug-84				0				0				0				0	1.073	1.073	1.073	1
47	Bessie Spring Upper; B-36-04 23DD	B-36-04 23DD	North	Kanab Creek - Lower	Perched	Spring	36.5021	-112.68322	27-May-82	27-May-82	650	650	650	1				0				0				0	0.5	0.5	0.5	1
48	Grama Spring; B-37-03 19CBC	B-37-03 19CBC	North	Kanab Plateau - South	Perched	Spring	36.58928	-112.66362	24-May-82	24-May-82	1105	1105	1105	1				0				0				0	0.4	0.4	0.4	1
49	Willow Spring; B-37-04 33BC	B-37-04 33BC	North	Kanab Plateau - South	Perched	Spring	36.56595	-112.73593	07-Jun-82	26-Aug-09	1340	3322	2958.75	8	0.5	5	1.5414286	7	0.06	78	21.794286	7	0.5	30.5	17.833333	6	0.4	0.4	0.4	1
50	South Water Canyon Spring; B-36-04 07AA	B-36-04 07AA	North	Kanab Plateau - South	Perched	Spring	36.5399	-112.75583	08-Jun-82	08-Jun-82				0				0				0				0	0.5	0.5	0.5	1
51	Unnamed seep (South Water Canyon); B-36-04 07C	B-36-04 07C	North	Kanab Plateau - South	Perched	Spring	36.532798895	-112.7668668	07-Jun-82	07-Jun-82				0				0				0				0	0.05	0.05	0.05	1
52	Buck Pasture Spring; B-37-05 15BC	B-37-05 15BC	North	Kanab Plateau - South	Perched	Spring	36.60715	-112.82534	01-Jul-85	01-Jul-85				0				0				0				0	0	0	0	1
54	Pigeon Spring; B-38-02 04ACA	B-38-02 04ACA	North	Snake Gulch	Perched	Spring	36.7241547	-112.5093567	15-Mar-82	15-Mar-82				0				0				0	44	44	44	1				0
59	Cedar Knoll (East); B-39-01 18DDB	B-39-01 18DDB	North	Kanab Plateau - North	Perched	Well	36.7755446	-112.4368555	06-Aug-69	12-Aug-69	1450	2220	1835	2				0				0				0				0
62	Burnt Canyon Well; B-39-04 24DBD	B-39-04 24DBD	North	Kanab Plateau - North	Perched	Well	36.76387575	-112.6707529	11-Aug-76	16-Sep-09	3310	3380	3345	2	13	13	13	1	0.76	0.76	0.76	1	2.77	2.77	2.77	1	50	50	50	1
63	Tom Land Well; B-38-05 36ADD	B-38-05 36ADD	North	Kanab Plateau - South	Perched	Well	36.651374	-112.7743665	14-Sep-09	14-Sep-09	1732.9	1732.9	1732.9	1	0.4	0.4	0.4	1				0	20.6	20.6	20.6	1	8.2	8.2	8.2	1
64	Hunt #5; 55-503919 (at Hermit Mine)	B-38-04 17CCA	North	Kanab Plateau - South	Perched	Well	36.689638493	-112.751931988	04-Aug-83	04-Aug-83	2980	2980	2980	1	28	28	28	1	24	24	24	1				0	2	2	2	1
65	Kanab #6; 55-509198	B-38-03 17CCA	North	Kanab Creek - Central	Regional	Well	36.689055789	-112.644278075	06-Dec-85	06-Dec-85	2570	2570	2570	1	5	5	5	1	10	10	10	1				0	10	10	10	1
66	Hack #10; 55-640855	B-37-05 26ABB	North	Kanab Plateau - South	Regional	Well	36.584829762	-112.798901564	04-Oct-82	01-Dec-83	3011	3970	3264.75	4	0.5	26	10.4	5	0.5	210	60.5	5	1.7	6.5	3.45	4	5	5	5	1
67	Hermit Well; B-38-04 17CCA	B-38-04 17CCA	North	Kanab Plateau - South	Regional	Well	36.6897078	-112.7521437	28-Apr-88	23-Nov-98				0	13	22	17.5	4				0	0.15	24	2.6211538	26				0
68	Pinenut Mine Monitor Well		North	Kanab Plateau - South	Regional	Well	36.5035510163	-112.734575	28-Apr-88	15-Sep-09	1410.5	1410.5	1410.5	1	6.22	34	15.37	6				0	0.25	12.2	3.7255556	27	13.6	13.6	13.6	1
69	Pigeon #4; 55-503711	B-38-02 05ABB	North	Snake Gulch	Regional	Well	36.728590192	-112.530070407	04-Oct-82	01-Dec-83	765	991	845.75	4	0.5	10	2.4	5	0.5	61	16	5	1.4	3.2	2	4	10	10	10	1
70	Hermit Mine Shaft		North	Kanab Plateau - South	Mine seepage	Shaft	36.6891666667	-112.7511111111	23-Aug-88	08-Dec-89				0	45	45	45	2				0	20.7	42	28.2	6				0
71	Hermit Mine Sump		North	Kanab Plateau - South	Mine seepage	Sump	36.6891666667	-112.7511111111	27-Jun-89	06-Feb-90				0	205	1090	522.75	4				0	3310	36600	15650	4				0
72	Hack Canyon #2 Mine Water		North	Kanab Plateau - South	Mine seepage	Sump	36.58219	-112.81059	01-Jun-85	01-Jun-85				0	100	100	100	1				0	22000	22000	22000	1				0
73	Pigeon Mine Main Sump		North	Snake Gulch	Mine seepage	Sump	36.7303996889	-112.5308169806	22-Aug-86	22-Aug-86	1920	1920	1920	1	5	5	5	1	0.5	0.5	0.5	1	170	170	170	1				0
74	Kanab Creek Downstream from Kanab North Mine	B-38-03 20A	North	Kanab Creek - Central	N/A	Stream	36.67967	-112.63296	22-Nov-82	10-Sep-87	820	3120	1849.5455	11	0.5	10	1.5	12	0.5	20	6.4166667	12	2	8.9	5.8909091	11	386	28187	8074.5	4
75	Kanab Creek Upstream from Kanab North Mine	B-38-03 17B	North	Kanab Creek - Central	N/A	Stream	36.68993	-112.62989	22-Nov-82	10-Sep-87	1021	3080	1992.5455	11	0.5	10	1.4166667	12	0.5	34	7.375	12	0.5	13.2	6.7545455	11	857	29309	8753.5	4

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
76	Kanab Creek Downstream from Clearwa-ter Spring	B-39-03 21B	North	Kanab Creek - Central	N/A	Stream	36.7698	-112.62076	09-Aug-84	10-Sep-87	934	2970	2164.8571	7	0.5	3	0.8571429	7	0.5	10	2.2142857	7	5.6	9.5	7.0857143	7				0
77	Kanab Creek Upstream from Hack Canyon	B-37-03	North	Kanab Creek - Lower	N/A	Stream	36.56195	-112.64723	22-Nov-82	10-Sep-87	1071	3560	2170.2857	7	0.5	10	1.75	8	0.5	41	12.0625	8	1	16.4	6.5	7	189	26122	7800.75	4
94	Johnson Spring; A-42-01 31DD	A-42-01 31DD	North Buffer	Kanab Plateau - North	Mesozoic	Spring	36.9908	-112.32415	14-May-79	14-May-79				0				0				0	47.27	47.27	47.27	1				0
95	Cow Seep; B-41-02 01AB	B-41-02 01AB	North Buffer	Kanab Plateau - North	Mesozoic	Spring	36.98753	-112.45672	31-Jul-85	31-Jul-85				0				0				0				0	0	0	0	1
96	Juniper Seep; B-42-02 36CA	B-42-02 36CA	North Buffer	Kanab Plateau - North	Mesozoic	Spring	36.99213	-112.46223	31-Jul-85	31-Jul-85				0				0				0				0	0	0	0	1
97	Shinarump Seep; B-41-02 01BBA	B-41-02 01BBA	North Buffer	Kanab Plateau - North	Mesozoic	Spring	36.98981	-112.45965	01-Jul-85	01-Jul-85	1885	1885	1885	1				0				0				0	0.1	0.1	0.1	1
98	B-42-02 36DB (seep)	B-42-02 36DB	North Buffer	Kanab Plateau - North	Mesozoic	Spring	36.91268	-112.46035	01-Jul-85	01-Jul-85				0				0				0				0	0	0	0	1
101	Pipe Spring; B-40-04 17DDB	B-40-04 17DDB	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.863124516	-112.740341567	27-Jul-76	10-Jun-08	280	367.25	309.42647	17	2	3.1	2.525	4	0.04	20	5.15	4				0	0	34.9	17.45	2
102	B-40-04 17DDB2	B-40-04 17DDB2	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.8635966	-112.740203	10-Dec-96	10-Dec-96	314	314	314	1	3	3	3	1	5	5	5	1				0				0
103	B-40-04 17DDB3	B-40-04 17DDB3	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.8635966	-112.740203	10-Dec-96	10-Dec-96	310	310	310	1	3	3	3	1	10	10	10	1				0				0
104	Long Res Spring; B-41-04 31ADC	B-41-04 31ADC	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.910541099	-112.760482673	17-Jan-69	09-Sep-76	135	135	135	1				0				0				0	89	90	89.4	3
105	Mocassin Spring; B-41-04 31CAB	B-41-04 31CAB	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.909707092	-112.768260949	17-Jan-69	09-Sep-76	208	208	208	1				0				0				0	23	42.85	32.925	2
106	Moccasin Spring; B-41-04 31DBB	B-41-04 31DBB	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.91008	-112.7631	17-Jan-69	10-Dec-96	118	118	118	2	0.5	0.5	0.5	1	5	5	5	1	0.352	0.352	0.352	1				0
108	West Cabin Spring; B-40-04 17DD	B-40-04 17DD	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.86322	-112.74023	08-Aug-00	08-Aug-00	244	244	244	1				0				0				0	0.48	0.48	0.48	1
109	Tunnel Spring; B-40-04 17DD	B-40-04 17DD	North Buffer	Moccasin Mtns	Mesozoic	Spring	36.86311	-112.73964	08-Aug-00	08-Aug-00	253	253	253	1				0				0				0	11.3	11.3	11.3	1
115	Coyote Spring; B-35-08 22DBD	B-35-08 22DBD	North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	36.415814435	-113.134100092	16-Aug-50	16-Aug-50				0				0				0				0	0.5	0.5	0.5	1
116	Nixon Spring; B-35-08 27CBC	B-35-08 27CBC	North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	36.402203357	-113.146878325	16-Aug-50	14-Aug-01	79	91	85	2				0				0				0	0.3	5.56	2.092	5
117			North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	36.392481318	-113.151767281	15-May-79	15-May-79				0				0				0	0.133	0.133	0.133	1				0
118	Orson Spring; B-35-08 23CDB	B-35-08 23CDB	North Buffer	Uinkaret Plateau - South	Mesozoic	Spring	36.41392	-113.12228	01-Jul-85	01-Jul-85				0				0				0				0	1.9	1.9	1.9	1
124	B-41-02 06CBB	B-41-02 06CBB	North Buffer	Fredonia, AZ	Mesozoic	Well	36.98220805	-112.5574246	25-Oct-75	25-Oct-75	2340	2340	2340	1				0				0				0	170	170	170	1
127	B-42-02 32BDB	B-42-02 32BDB	North Buffer	Fredonia, AZ	Mesozoic	Well	36.99998578	-112.534647	10-Aug-76	10-Aug-76	1210	1210	1210	1				0				0				0				0
128			North Buffer	Fredonia, AZ	Mesozoic	Well	37.006485784	-112.527158149	10-Jul-80	10-Jul-80				0				0				0	0.308	0.308	0.308	1				0
129			North Buffer	Fredonia, AZ	Mesozoic	Well	36.998185803	-112.534558104	14-May-79	14-May-79				0				0				0	3.33	3.33	3.33	1				0
144	C-43-05 25CDB2	C-43-05 25CDB2	North Buffer	Kanab Plateau - North	Mesozoic	Well	37.0394297	-112.3715862	27-Sep-77	27-Sep-77	1080	1080	1080	1				0				0				0				0
145	C-44-05 06CBB1	C-44-05 06CBB1	North Buffer	Kanab Plateau - North	Mesozoic	Well	37.0138747	-112.4632562	30-Sep-76	03-Aug-09	1610	3640	1971.2059	17	0.65	1.1	0.8833333	3				0	1.11	1.38	1.25275	4				0
147	B-41-04 31ACD	B-41-04 31ACD	North Buffer	Moccasin Mtns	Mesozoic	Well	36.9110962	-112.7621496	17-Jan-69	17-Jan-69	130	130	130	1				0				0				0				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
150	B-41-04 31DBB	B-41-04 31DBB	North Buffer	Moccasin Mtns	Mesozoic	Well	36.9097073	-112.7660386	20-Mar-97	20-Mar-97	135	135	135	1	2	2	2	1	20	20	20	1				0	80	80	80	1
153	B-39-08 05ADB	B-39-08 05ADB	North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	36.8119291	-113.1724438	11-Aug-76	11-Aug-76	2860	2860	2860	1				0				0				0				0
154	B-39-08 05DBA	B-39-08 05DBA	North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	36.81026247	-113.1724438	09-May-79	09-May-79				0				0				0	13.19	13.19	13.19	1				0
156	B-39-08 27AAB	B-39-08 27AAB	North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	36.7577627	-113.1366084	10-May-79	10-May-79				0				0				0	25.7	25.7	25.7	1				0
158			North Buffer	Uinkaret Plateau - Central	Mesozoic	Well	36.79658488	-113.125174678	09-May-79	09-May-79				0				0				0	33.22	33.22	33.22	1				0
159	B-40-05 20CCC	B-40-05 20CCC	North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.84692975	-112.8632632	12-May-79	12-May-79				0				0				0	0.256	0.256	0.256	1				0
166	B-40-06 29AAB	B-40-06 29AAB	North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.8452629	-112.957156	12-May-79	12-May-79				0				0				0	0.109	0.109	0.109	1				0
168	B-40-06 30AAA	B-40-06 30AAA	North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.8460962	-112.97299	05-Aug-76	05-Aug-76	2520	2520	2520	1				0				0				0				0
170	B-40-06 32AAA	B-40-06 32AAA	North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.8310963	-112.9546557	07-Aug-76	07-Aug-76	1490	1490	1490	1				0				0				0				0
172	B-40-07 04CCC	B-40-07 04CCC	North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.890818	-113.0604946	11-Aug-76	11-Aug-76	3460	3460	3460	1				0				0				0				0
175	B-40-08 17DCB	B-40-08 17DCB	North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.86387346	-113.176333	12-Aug-76	08-May-79	3860	3860	3860	1				0				0	31.748	31.748	31.748	1				0
178			North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.875984655	-113.117474809	08-May-79	08-May-79				0				0				0	3.566	3.566	3.566	1				0
179	Atkins Well; B-41-08 10BA	B-41-08 10BA	North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.88958	-113.14547	08-May-79	08-May-79				0				0				0	6.514	6.514	6.514	1				0
180			North Buffer	Uinkaret Plateau - North	Mesozoic	Well	36.871584938	-112.97766842	14-May-79	14-May-79				0				0				0	3.578	3.578	3.578	1				0
181	Hotel Spring; B-34-04 07A	B-34-04 07A	North Buffer	150-mile Canyon	Perched	Spring	36.36401	-112.75762	23-May-05	25-Aug-09	594.75	594.75	594.75	1	6.46	6.46	6.46	1				0	2.7	4.17	3.2466667	3				0
182	Buckhorn Spring; B-34-05 01BA	B-34-05 01BA	North Buffer	150-mile Canyon	Perched	Spring	36.38236	-112.77933	23-May-05	29-Nov-05				0				0				0	10.3	10.6	10.45	2				0
186	Lower Jumpup Spring; B-36-03 11BD	B-36-03 11BD	North Buffer	Jumpup Canyon	Perched	Spring	36.53765	-112.58523	28-Aug-09	28-Aug-09	1254.5	1254.5	1254.5	1	1.42	1.42	1.42	1				0	7.6	7.6	7.6	1	57.6	57.6	57.6	1
187	Mountain Sheep Spring; B-36-03 13	B-36-03 13	North Buffer	Jumpup Canyon	Perched	Spring	36.52325	-112.567361	01-Sep-09	01-Sep-09	1067.95	1067.95	1067.95	1	1.3	1.3	1.3	1				0	8.37	8.37	8.37	1				0
188	Upper Jumpup Spring; B-37-02 30	B-37-02 30	North Buffer	Jumpup Canyon	Perched	Spring	36.58075	-112.546778	27-Aug-09	27-Aug-09	460.85	460.85	460.85	1	1.06	1.06	1.06	1				0	3.94	3.94	3.94	1	1.3	1.3	1.3	1
189			North Buffer	Jumpup Canyon	Perched	Spring	36.52083333	-112.57388889	01-Sep-09	01-Sep-09				0				0				0	7.76	7.76	7.76	1				0
198	Warm Springs; A-38-01 17ACA	A-38-01 17ACA	North Buffer	Kaibab Plateau	Perched	Spring	36.695267514	-112.31323707	08-Aug-76	03-Jul-00	293	360.75	335.58333	3				0				0	0.71	0.71	0.71	1	5.7	5.7	5.7	1
202	Daves Canyon Spring; B-36-03 30CC	B-36-03 30CC	North Buffer	Kanab Creek - Lower	Perched	Spring	36.48655	-112.66276	28-May-82	29-Aug-84	640	1430	1035	2				0				0				0	0.3	0.75	0.525	2
203	B&H Spring; B-35-04 12AB	B-35-04 12AB	North Buffer	Kanab Creek - Lower	Perched	Spring	36.45347	-112.67153	29-Aug-84	29-Aug-84	640	640	640	1				0				0				0	1.4	1.4	1.4	1
204	Dripping Spring North; B-35-04 12CC	B-35-04 12CC	North Buffer	Kanab Creek - Lower	Perched	Spring	36.4434	-112.6753	07-Jun-82	07-Jun-82	1750	1750	1750	1				0				0				0	0.75	0.75	0.75	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
205	Dripping Spring South; B-35-04 13BB	B-35-04 13BB	North Buffer	Kanab Creek - Lower	Perched	Spring	36.43946	-112.67862	07-Jun-82	07-Jun-82	2275	2275	2275	1				0				0				0	0.5	0.5	0.5	1
207	Wildband Spring; B-38-02 04DC	B-38-02 04DC	North Buffer	Snake Gulch	Perched	Spring	36.71712	-112.51015	15-Mar-82	15-Mar-82				0				0				0	14	14	14	1				0
208	Rock Spring; B-38-03 24BB	B-38-03 24BB	North Buffer	Snake Gulch	Perched	Spring	36.68363	-112.57341	15-Mar-82	02-Sep-09	1599	1599	1599	1	0.4	0.4	0.4	1				0	12.7	15	13.85	2	0.11	0.11	0.11	1
209	Little Slide Spring; B-38-03 25	B-38-03 25	North Buffer	Snake Gulch	Perched	Spring	36.65803	-112.56238	15-Mar-82	27-Aug-09	779.35	779.35	779.35	1	0.77	0.77	0.77	1				0	1.5	2.83	2.165	2	89.8	89.8	89.8	1
210	Table Rock Spring; B-38-02 12B	B-38-02 12B	North Buffer	Snake Gulch	Perched	Spring	36.71141	-112.46396	15-Mar-82	15-Mar-82				0				0				0	5.2	5.2	5.2	1				0
211	Upper Willow Spring; B-38-02 08AC	B-38-02 08AC	North Buffer	Snake Gulch	Perched	Spring	36.70996	-112.52865	15-Mar-82	15-Mar-82				0				0				0	10	10	10	1				0
216	Schmutz Spring; B-34-06 10DBB	B-34-06 10DBB	North Buffer	Tuckup Canyon	Perched	Spring	36.36164	-112.91952	26-May-05	25-Aug-09	1041.3	1041.3	1041.3	1	1.82	1.82	1.82	1				0	4.25	5.98	4.796	5				0
221	B-34-04 16D	B-34-04 16D	North Buffer	Grand Canyon - Central	Regional	Spring	36.346371969	-112.725470752	07-May-76	07-May-76	1384.5	1384.5	1384.5	1				0				0	8.5	8.5	8.5	1	1	1	1	1
222	Kanab Spring; B-35-03 05-2	B-35-03 05-2	North Buffer	Kanab Creek - Lower	Regional	Spring	36.465528	-112.628694	26-Aug-09	26-Aug-09	561.6	561.6	561.6	1	1.77	1.77	1.77	1				0	4.83	5.17	5	2	274	274	274	1
223	Shower Bath Spring; B-35-03 05-1	B-35-03 05-1	North Buffer	Kanab Creek - Lower	Regional	Spring	36.456806	-112.642667	26-Aug-09	26-Aug-09	455	455	455	1	1.42	1.42	1.42	1				0	4.74	4.74	4.74	1	202	202	202	1
224	Side Canyon Spring; B-35-04 12	B-35-04 12	North Buffer	Kanab Creek - Lower	Regional	Spring	36.450361	-112.663972	26-Aug-09	26-Aug-09	855.4	855.4	855.4	1	1.69	1.69	1.69	1				0	7.44	7.44	7.44	1	1	1	1	1
225	Kanab Creek Downstream from Snake Gulch	B-37-03	North Buffer	Kanab Creek - Central	N/A	Stream	36.63593	-112.62643	22-Nov-82	10-Sep-87	1003	2700	1710.5	10	0.5	10	1.4090909	11	0.5	21	6.4545455	11	2	11.1	7.2	10	467	31912	9867.5	4
226	Kanab Creek Downstream from Hack Canyon	B-36-03	North Buffer	Kanab Creek - Lower	N/A	Stream	36.54911	-112.65096	22-Nov-82	10-Sep-87	1051	3300	2156.7143	7	0.5	10	1.75	8	0.5	49	16.3125	8	0.5	18.9	6.9857143	7	189	28860	8126.25	4
227	Cottonwood Creek North Rim Grand Canyon		North Buffer	Tuckup Canyon	N/A	Stream	36.32972222	-112.91722222	26-May-05	30-Nov-05				0				0				0	4.82	5	4.91	2				0
233	A-37-05 04ABC	A-37-05 04ABC	East	Marble Platform	Mesozoic	Well	36.6394312	-111.8648899	04-Aug-76	04-Aug-76	4200	4200	4200	1				0				0				0				0
236	01 029-01.85X10.42		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	36.848877531	-111.534324602	18-Sep-59	18-Sep-59				0				0				0				0	5	5	5	1
237	Lee's Ferry Spring; A-40-08 18DBC	A-40-08 18DBC	East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	36.863876825	-111.57821557	01-Aug-59	04-Aug-76	397	397	397	1				0				0				0	0.3	0.3	0.3	1
238	Frog Marsh Spring (Below Dam)		East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	36.84580556	-111.55725	02-Mar-95	01-May-95				0				0				0	0.6	0.63	0.615	2				0
239	Lees Ferry Spring; A-40-08 18DB	A-40-08 18DB	East Buffer	Lees Ferry Vicinity	Mesozoic	Spring	36.86667	-111.55833	13-Feb-02	13-Feb-02				0				0				0				0	0	0	0	1
240	Navajo Spring; 03 029-05.59X16.13		East Buffer	Marble Platfrom	Mesozoic	Spring	36.765821549	-111.60154737	30-Apr-52	30-Apr-52	171	171	171	1				0				0				0	8	8	8	1
241	Bitterspring; 03 044-08.12X06.27		East Buffer	Marble Platfrom	Mesozoic	Spring	36.658321067	-111.646547548	30-Apr-52	30-Apr-52	3390	3390	3390	1				0				0				0	3	3	3	1
245	Coyote Springs; A-41-03 13CBC	A-41-03 13CBC	East Buffer	Paria Plateau	Mesozoic	Spring	36.95192973	-112.03490272	06-Aug-76	19-May-79	372	372	372	1				0				0	0.794	0.794	0.794	1	1.22	1.22	1.22	1
246	Cottonwood Spring; A-41-04 08CAA	A-41-04 08CAA	East Buffer	Paria Plateau	Mesozoic	Spring	36.96809	-111.99236	01-Jul-85	01-Jul-85				0				0				0				0	7	7	7	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
249	Wilson Canyon Seeps; A-40-07 05AA	A-40-07 05AA	East Buffer	Paria Plateau	Mesozoic	Spring	36.90042	-111.66096	01-Apr-82	01-Apr-82				0				0				0				0	0.1	0.1	0.1	1
251	Badger Spring; A-39-06 12BAD	A-39-06 12BAD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.79915384	-111.70488612	06-Aug-76	06-Aug-76	109	109	109	1				0				0				0				0
252	Soap Creek Spring East; A-39-06 17DA	A-39-06 17DA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.77792	-111.76996	04-Aug-76	03-Jul-88	148	247	197.5	2				0				0				0	7.8	18	12.9	2
253	Lowrey Spring; A-40-07 30A	A-40-07 30A	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.84013	-111.68136	01-Jan-56	01-Jul-85	152	377	264.5	2				0				0				0	3.5	3.5	3.5	1
254	Unnamed (two Mile Spring); A-40-03 34DAA	A-40-03 34DAA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.82347	-112.05596	18-May-79	18-May-79				0				0				0	5.05	5.05	5.05	1				0
255	Jacob Cliff; A-38-05 06AA	A-38-05 06AA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.72858	-111.89771	19-May-79	19-May-79				0				0				0	2.396	2.396	2.396	1				0
258	One Mile Spring; A-39-03 03DA	A-39-03 03DA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.80661	-112.05492	01-Jul-85	01-Jul-85	292.5	292.5	292.5	1				0				0				0	1.6	1.6	1.6	1
259	Deer Spring; A-39-03 11BB	A-39-03 11BB	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.79864	-112.05336	01-Jul-85	01-Jul-85	221	221	221	1				0				0				0	0.25	0.25	0.25	1
265	Hancock Spring; A-39-05 31BA	A-39-05 31BA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.74193	-111.90403	01-Jul-85	01-Jul-85				0				0				0				0	2	2	2	1
267	Emmett Spring; A-38-05 08A	A-38-05 08A	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.71102	-111.87558	01-Jul-85	01-Jul-85	351	351	351	1				0				0				0	2	2	2	1
268	Jacob Cliff Spring East; A-38-05 06AA	A-38-05 06AA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.72747	-111.89573	01-Jul-85	01-Jul-85				0				0				0				0	0.5	0.5	0.5	1
269	Jacob Cliff Spring Main; A-38-05 06BA	A-38-05 06BA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.72842	-111.90332	01-Jul-85	01-Jul-85				0				0				0				0	1	1	1	1
270	Jacob Cliff Spring North; A-38-05 06BA	A-38-05 06BA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.72784	-111.90154	01-Jul-85	01-Jul-85				0				0				0				0	0.5	0.5	0.5	1
271	Cottonwood Seeps; A-39-06 21CB	A-39-06 21CB	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.7632	-111.7634	03-Jul-88	03-Jul-88				0				0				0				0	0.5	0.5	0.5	1
273	Dutchman Spring; A-39-06 10DBD	A-39-06 10DBD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.79225	-111.73646	01-Jul-85	02-Jul-88	240.5	438.75	339.625	2				0				0				0	0.2	0.7	0.45	2
275	Halfmoon Seep; A-39-06 29CDB	A-39-06 29CDB	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.75111	-111.77963	05-Jul-88	05-Jul-88				0				0				0				0	0.1	0.1	0.1	1
276	Walts Spring; A-39-06 30DBC	A-39-06 30DBC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.74829	-111.79217	01-Jul-85	05-Jul-88	149.5	149.5	149.5	1				0				0				0	0.75	2	1.375	2
280	Seven Mile Spring Upper; A-40-06 36ADD	A-40-06 36ADD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.82431	-111.69641	01-Jul-85	01-Jul-85	182	182	182	1				0				0				0	0.6	0.6	0.6	1
282	Seven Mile Spring Lower; A-40-06 36DD	A-40-06 36DD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.81825	-111.69554	01-Jul-85	01-Jul-85	529.75	529.75	529.75	1				0				0				0	0.1	0.1	0.1	1
284	Smokey Spring; A-39-06 19DA	A-39-06 19DA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.76438	-111.78562	01-Jul-85	04-Jul-88	195	195	195	1				0				0				0	2	10	6	2
285	Soap Spring; A-39-06 17AD	A-39-06 17AD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.7769	-111.76972	08-Aug-85	08-Aug-85	256.75	256.75	256.75	1				0				0				0	6.3	6.3	6.3	1
287	908 Spring; A-39-03 25AA	A-39-03 25AA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.75541	-112.02146	01-Jul-85	01-Jul-85				0				0				0				0	0	0	0	1
288	Banal Spring; A-39-04 27AB	A-39-04 27AB	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.75775	-111.95535	07-Aug-85	07-Aug-85	211.25	211.25	211.25	1				0				0				0	0.8	0.8	0.8	1
289	Combination Seeps; A-39-06 20C	A-39-06 20C	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.76231	-111.78256	04-Jul-88	04-Jul-88				0				0				0				0	0.7	0.7	0.7	1
290	Cottonwood Spring Upper; A-39-06 21CB	A-39-06 21CB	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.76314	-111.76501	05-Jul-88	05-Jul-88	234	234	234	1				0				0				0	2.4	2.4	2.4	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
291	Cottonwood Spring Lower; A-39-06 21CB	A-39-06 21CB	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.76177	-111.76333	08-Aug-85	08-Aug-85	318.5	318.5	318.5	1				0				0				0	1.4	1.4	1.4	1
292	Early Seep; A-39-06 01CC	A-39-06 01CC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.80379	-111.71043	01-Jul-88	01-Jul-88				0				0				0				0	0.1	0.1	0.1	1
293	Eyewhere Seep; A-39-06 29DB	A-39-06 29DB	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.74991	-111.77813	05-Jul-88	05-Jul-88				0				0				0				0	0.1	0.1	0.1	1
294	Fisher Springs Upper; A-40-07 16ADC	A-40-07 16ADC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.86856	-111.6454	01-Jul-85	01-Jul-85				0				0				0				0	0.5	1.5	1	2
295	Hod Brown Seep West; A-39-03 13BC	A-39-03 13BC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.78122	-112.03468	01-Jul-85	01-Jul-85				0				0				0				0	0.2	0.2	0.2	1
296	Hod Brown Seep East; A-39-03 13BC	A-39-03 13BC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.78122	-112.03468	01-Jul-85	01-Jul-85				0				0				0				0	0.3	0.3	0.3	1
297	Hod Brown Spring; A-39-03 13BC	A-39-03 13BC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.78122	-112.03468	01-Apr-81	01-Apr-81				0				0				0				0	0.2	0.2	0.2	1
298	Ima Spring; A-39-06 20DC	A-39-06 20DC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.75959	-111.773	04-Jul-88	04-Jul-88	214.5	214.5	214.5	1				0				0				0	0.9	0.9	0.9	1
299	Ima Seep; A-39-06 20DC	A-39-06 20DC	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.75959	-111.773	04-Jul-88	04-Jul-88				0				0				0				0	0.1	0.1	0.1	1
300	Laurita Spring; A-39-06 19DD	A-39-06 19DD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.76062	-111.78666	04-Jul-88	04-Jul-88				0				0				0				0	1	1	1	1
301	Lightening Spring; A-39-06 20AA	A-39-06 20AA	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.77185	-111.76825	03-Jul-88	03-Jul-88	341.25	341.25	341.25	1				0				0				0	1.9	1.9	1.9	1
302	Old Juniper Spring; A-39-06 20CD	A-39-06 20CD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.76125	-111.77727	04-Jul-88	04-Jul-88	396.5	396.5	396.5	1				0				0				0	1.2	1.2	1.2	1
303	Lower Badger Spring; A-39-06 01D	A-39-06 01D	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.80668	-111.69898	01-Jul-85	01-Jul-85				0				0				0				0	5	5	5	1
304	Parker Spring; A-39-04 30BD	A-39-04 30BD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.75302	-112.01142	01-Jul-85	01-Jul-85	812.5	812.5	812.5	1				0				0				0				0
305	Unknown Private Spring; A-40-03 34DD	A-40-03 34DD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.81862	-112.0572	01-Jul-85	01-Jul-85	256.75	256.75	256.75	1				0				0				0	2	2	2	1
306	A-39-06 29B (seep)	A-39-06 29B	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Spring	36.75517	-111.78076	08-Aug-85	08-Aug-85				0				0				0				0	0	0	0	1
309	A-40-07 13ACC	A-40-07 13ACC	East Buffer	Lees Ferry Vicinity	Mesozoic	Well	36.86776537	-111.5946051	04-Feb-69	04-Feb-69	1580	1580	1580	1				0				0				0				0
311	A-40-08 18CBA	A-40-08 18CBA	East Buffer	Lees Ferry Vicinity	Mesozoic	Well	36.86609887	-111.5823824	10-Nov-42	15-May-44	1260	1680	1470	2				0				0				0				0
313	A-39-04 06CBB	A-39-04 06CBB	East Buffer	Paria Plateau	Mesozoic	Well	36.80804305	-112.017398	05-Aug-76	05-Aug-76	294	294	294	1				0				0				0				0
318	A-41-04 28ADA	A-41-04 28ADA	East Buffer	Paria Plateau	Mesozoic	Well	36.9277635	-111.9640654	06-Aug-76	06-Aug-76	205	205	205	1				0				0				0				0
319			East Buffer	Paria Plateau	Mesozoic	Well	36.925785783	-111.970732329	20-May-79	20-May-79				0				0				0	0.607	0.607	0.607	1				0
320	A-39-03 03DBD	A-39-03 03DBD	East Buffer	Vermilion Cliffs (AZ)	Mesozoic	Well	36.80498806	-112.0596214	05-Aug-76	05-Aug-76	270	270	270	1				0				0				0				0
321	Kane Spring; A-37-03 23CD	A-37-03 23CD	East Buffer	Kaibab Plateau	Perched	Spring	36.58589	-112.04517	19-May-79	19-May-79				0				0				0	0.772	0.772	0.772	1				0
326	Rider Spring; A-38-06 31	A-38-06 31	East Buffer	Marble Platform	Perched	Spring	36.651944	-111.788056	25-Aug-09	25-Aug-09	897	897	897	1	5	5	5	1				0	4.64	4.64	4.64	1	0.02	0.02	0.02	1
327	South Canyon Spring; A-36-05 31	A-36-05 31	East Buffer	Marble Platform	Perched	Spring	36.482222	-111.906389	26-Aug-09	26-Aug-09				0	1.44	1.44	1.44	1				0	0.82	0.82	0.82	1				0
331	Vasey's Paradise Spring; A-36-05 27B	A-36-05 27B	East Buffer	Marble Canyon	Regional	Spring	36.499153222	-111.857943296	08-Aug-23	21-Aug-09	163	221	188.57143	7	1.3	4.6	2.6333333	3				0	0.57	1.8	1.2784733	3	67.2	4480	1449.2754	14
332	Hanging Spring; A-36-05 34A	A-36-05 34A	East Buffer	Marble Canyon	Regional	Spring	36.476930209	-111.845720434	29-Apr-76	22-Aug-09	194	234	214	2	2.3	2.3	2.3	1	0.03	0.03	0.03	1	0.5	0.61	0.555	2	15	15	15	1
333	A-36-05 14; Fence Spring	A-36-05 14	East Buffer	Marble Canyon	Regional	Spring	36.523056	-111.841944	20-Aug-09	20-Aug-09	1131	1131	1131	1	16.6	16.6	16.6	1				0	1.48	1.48	1.48	1	732	732	732	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
334	Hole in the Wall Spring; A-36-05 34DBA UN-SURVEYED		East Buffer	Marble Canyon	Regional	Spring	36.475278	-111.845556	22-Aug-09	22-Aug-09	196.95	196.95	196.95	1	2.4	2.4	2.4	1				0	0.6	0.6	0.6	1	8.8	8.8	8.8	1
335	Hanging Springs; A-36-05 34	A-36-05 34	East Buffer	Marble Canyon	Regional	Spring	36.47378	-111.84561	21-Aug-09	21-Aug-09	214.5	214.5	214.5	1	2.4	2.4	2.4	1				0	0.6	0.6	0.6	1	0.68	0.68	0.68	1
336	River Mile 25.3; East bank		East Buffer	Marble Canyon	Regional	Spring	36.5756989548	-111.794093644	19-Sep-82	19-Sep-82	540	540	540	1	4	4	4	1				0	2.1888889	2.1888889	2.1888889	1	5	5	5	1
337	Fence Fault River Left		East Buffer	Marble Canyon	Regional	Spring	36.51885	-111.8458917	19-Sep-82	12-Oct-07	1008	1500	1254	2	18	18	18	1				0	2.4333333	2.4333333	2.4333333	1	17	17	17	1
338	River Mile 30.6: East bank		East Buffer	Marble Canyon	Regional	Spring	36.5179057511	-111.845830322	19-Sep-82	19-Sep-82	1500	1500	1500	1	21	21	21	1				0	2.3444444	2.3444444	2.3444444	1	1500	1500	1500	1
339	Fence Fault River Right		East Buffer	Marble Canyon	Regional	Spring	36.5155167	-111.8479639	19-Sep-82	12-Oct-07	809	1500	1154.5	2	15	15	15	1				0	1.9777778	1.9777778	1.9777778	1	1000	1000	1000	1
340	River Mile 30.7; West bank		East Buffer	Marble Canyon	Regional	Spring	36.5168034074	-111.847410344	19-Sep-82	19-Sep-82	1500	1500	1500	1	13	13	13	1				0	2.3111111	2.3111111	2.3111111	1	35	35	35	1
341	River Mile 30.7; East bank; Marble Platform end member		East Buffer	Marble Canyon	Regional	Spring	36.5164682212	-111.846115093	19-Sep-82	19-Sep-82	1600	1600	1600	1	20	20	20	1				0	2.5	2.5	2.5	1	150	150	150	1
342	River Mile 35.0; West bank		East Buffer	Marble Canyon	Regional	Spring	36.4701527469	-111.841452938	19-Sep-82	19-Sep-82	200	200	200	1	2	2	2	1				0	1.3777778	1.3777778	1.3777778	1	5	5	5	1
343	River Mile 31.2; West bank; Kaibab Plateau end member		East Buffer	Marble Canyon	Regional	Spring	36.5102826648	-111.850994644	19-Sep-82	19-Sep-82	200	200	200	1	5.6	5.6	5.6	1				0	1.4444444	1.4444444	1.4444444	1	250	250	250	1
345	Fence Fault north; A-36-05 15A	A-36-05 15A	East Buffer	Marble Canyon	Regional	Spring	36.52575	-111.84546	26-Mar-01	26-Mar-01	987	987	987	1				0				0				0	300	300	300	1
349	03 044-07.96X06.25		East Buffer	Marble Platfrom	N/D	Well	36.65887698	-111.6448812	07-Oct-56	07-Oct-56	2353	2353	2353	1				0				0				0				0
354	A-30-02 25C	A-30-02 25C	South	Coconino Plateau - East	Perched	Well	35.95276278	-112.1285012	31-Dec-63	31-Dec-63	658	658	658	1				0				0				0				0
356	Canyon Mine Well; A-29-03 20BDB	A-29-03 20BDB	South	Coconino Plateau - East	Regional	Well	35.88554296	-112.0954438	18-Dec-86	18-Sep-09	168	366	243.24107	28	0.26	5	1.2133333	27	0.35	1.9	1.125	2	4.1	16	11.7	10	34	70	52	2
359	A-30-02 24CAB	A-30-02 24CAB	South	Coconino Plateau - East	Regional	Well	35.97023439	-112.1309182	10-Jun-93	18-Jun-08	244	263	248	10	2	2.3	2.1333333	3	0.06	1.7	0.7533333	3				0				0
367	Dripping Spring		South Buffer	Grand Can-yon - South Rim	Perched	Spring	36.063333	-112.243167	17-Mar-95	04-May-09	152	224.25	181.75	3				0				0	2.4	2.4	2.4	1	1	1	1	1
368	Santa Maria Spring		South Buffer	Grand Can-yon - South Rim	Perched	Spring	36.06	-112.221944	17-Mar-95	12-Nov-08	145	244	214.5	4				0				0	7.2	7.2	7.2	1	0.5	0.5	0.5	1
369	Kolb Spring		South Buffer	Grand Can-yon - South Rim	Perched	Spring	36.0577778	-112.1427778	01-Jan-94	01-Jan-94				0				0				0				0	0.5	0.5	0.5	1
381	Rowe Well; A-31-02 33ABB	A-31-02 33ABB	South Buffer	Coconino Plateau - East	Perched	Well	36.03470517	-112.1801704	18-May-07	02-Dec-08	349	420.3	400.575	4				0				0				0				0
382	B-29-01 12DBD	B-29-01 12DBD	South Buffer	Coconino Plateau - East	Perched	Well	35.90831956	-112.3396186	14-Oct-66	14-Oct-66	594	594	594	1				0				0				0				0
384	B-30-01 28AAA2	B-30-01 28AAA2	South Buffer	Coconino Plateau - East	Perched	Well	35.9638735	-112.3868429	03-Jun-58	12-Aug-86	1080	1120	1100	2	0.5	0.5	0.5	1	5	5	5	1				0				0
386			South Buffer	Coconino Plateau - East	Perched	Well	36.012683176	-112.298929421	31-May-79	31-May-79				0				0				0	0.598	0.598	0.598	1				0
387	Grapevine Main Spring		South Buffer	Grand Can-yon - South Rim	Regional	Spring	36.0110909	-112.0033028	10-Apr-01	15-Nov-01	225.55	240.5	234	3				0				0	1.0569556923	1.0735073765	1.0652315344	2	0	0	0	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
388	VT9 Miners Spring at Trail in Hance Canyon		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.01637288	-111.972108	20-Nov-81	06-Jun-02	191	261.3	228.6611111111	9	17	20	18.75	4				0	3.1195428675	4.1	3.6202057477	6	0	1.5	0.4	4
389	Hance Creek Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0000694	-111.9525	08-Apr-01	11-May-01	273	323.7	298.35	2	14	14	14	1				0	3.4661269514	4.0837862234	3.7749565874	2				0
390	Red Canyon Spring; A-30-04 11 Unsurveyed	A-30-04 11	South Buffer	Grand Canyon - South Rim	Regional	Spring	36.00554019	-111.9351617	26-Sep-01	26-Sep-01	190.45	190.45	190.45	1	17	17	17	1				0	1.6849202219	1.6849202219	1.6849202219	1	4.488312	4.488312	4.488312	1
391	Boucher Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0897709	-112.2603246	25-Apr-02	25-Apr-02	528.45	528.45	528.45	1				0				0				0	0	0	0	1
392	Two Trees Spring (Pumphouse Spring)		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0775307	-112.1261403	30-Apr-94	17-Sep-08	115	326.95	224.965	10				0				0	1.701516414	3.2	2.3293576416	5	0	221	110.5	2
393	Salt creek at Source		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0768635	-112.161769	23-May-00	13-Nov-08	342	794	483.69	5				0				0	29.2676946643	31.1881617114	30.1885221545	3	0	0	0	1
394	A-31-02 18 2 Unsurveyed	A-31-02 18 2	South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0713713	-112.2193385	11-Apr-01	19-Nov-01	271.05	286	278.525	2				0				0				0	179.53248	179.53248	179.53248	1
395	A-31-03 14 Unsurveyed	A-31-03 14	South Buffer	Grand Canyon - South Rim	Regional	Spring	36.06664989	-112.0479446	11-Apr-01	01-May-01	428.35	429	428.675	2				0				0	6.0206077449	6.0488672653	6.0347375051	2				0
396	Grapevine East Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0422846	-112.012395	12-Nov-94	05-Nov-08	240	806	515.6607142857	14				0				0	2.0968705619	8.2665978465	5.1261612731	4	0	6.42	1.4523988546	10
397	A-31-04 32	A-31-04 32 1	South Buffer	Grand Canyon - South Rim	Regional	Spring	36.02442815	-111.9882199	29-Nov-00	09-Apr-01	273.65	288.6	281.125	2				0				0				0				0
398	A-31-04 32 Unsurveyed	A-31-04 32 2	South Buffer	Grand Canyon - South Rim	Regional	Spring	36.02444	-111.98667	25-May-00	25-May-00	572	572	572	1				0				0				0	0	0	0	1
399	A-32-01 02 Unsurveyed	A-32-01 02	South Buffer	Grand Canyon - South Rim	Regional	Spring	36.19470315	-112.3537885	21-Apr-02	21-Apr-02	319.8	319.8	319.8	1				0				0				0	0	0	0	1
400	A-32-01 19 Unsurveyed	A-32-01 19	South Buffer	Grand Canyon - South Rim	Regional	Spring	36.13803717	-112.330176	22-Apr-02	22-Apr-02	663	663	663	1				0				0				0	0	0	0	1
402	Pipe Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0718389	-112.1023579	11-Jan-94	29-Jul-02	270	399.1	326.1714285714	7				0				0	3.1	3.6	3.3166666667	6	0.92	104	36.4694373333	3
403	Horn Creek at base of Redwall-Muav Limestone contact		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.07802	-112.14559	04-Jun-02	29-Jul-02				0				0				0	333	400	357.25	4				0
404	Burro Spring Source		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.076637548	-112.100341433	01-Sep-81	30-Dec-08	267	1072	432	6	1	1	1	1				0	2.6	4.4	3.6833333333	6	4	8.976624	5.972208	3
405	Horn West Spring; small dripping spring sampled directly at issue at Redwall-Muav Limestone contact		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.08029	-112.15057	15-Jul-02	29-Jul-02				0				0				0	135	202	168.5	2				0
406	Cottonwood Spring above the Confluence with Cotton		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0235948	-111.9882199	28-Sep-94	14-Jan-09	285	618	365.6083333333	18				0				0	1.6005094229	2.1	1.8502547115	2	0	10.3231176	3.285658544	78
407	Horn Creek / Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.08462	-112.14128	30-Apr-94	22-Nov-02	312	527	451.0714285714	7				0				0	18.9	67.8	36.0666666667	3	0	0.5	0.1666666667	3
408	Grapevine Hell Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.04115	-112.0229417	13-May-95	13-May-95	892	892	892	1				0				0	8.3	8.3	8.3	1				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date
409	Hawaii Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0706411	-112.2190538	18-Mar-95	11-Apr-01
410	Grapevine Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.023167	-112.013167	12-Nov-94	17-Jul-95
411	Sam Magee Spring (Cremation East)		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0774974	-112.0631939	10-Jan-94	27-Feb-08
412	Hermit Source Spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0645	-112.225167	21-Jul-95	30-Dec-05
413	Monument Creek at source spring		South Buffer	Grand Canyon - South Rim	Regional	Spring	36.0656137	-112.1763915	05-Dec-00	13-Nov-08
443	Two Tree Spring at Gage near Pumphouse		South Buffer	Grand Canyon - South Rim	Regional	Spring stream	36.078339568	-112.126405567	17-May-85	30-Dec-08
444	Horn Creek at potential downstream flow of Horn Creek Up and Down sites		South Buffer	Grand Canyon - South Rim	Regional	Stream	36.08325	-112.14364	29-Jul-02	29-Jul-02
446	Hance Rapid Spring		South Buffer	Grand Canyon - East	Below regional	Spring	36.0538703487	-111.9229303567	13-May-98	13-May-98
451	Boucher East Spring; upper Tapeats (travertine dome)		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.1007013515	-112.237245484	26-May-00	12-Apr-01
452	A-31-03 15 UNSURVEYED	A-31-03 15	South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.0869274	-112.0785013	20-Apr-01	20-Apr-01
453	Lonetree Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.0715972	-112.0460028	09-Jan-94	05-Nov-08
454	Boulder Creek Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.056187	-112.0350906	10-Jan-94	18-Oct-06
455	Cedar Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.08974	-112.17856	18-Mar-95	13-Nov-08
456	Cottonwood West Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.0368578	-111.9974578	13-May-95	05-Nov-08
457	Monument Creek / Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.08233	-112.185667	18-Mar-95	05-Dec-00
458	Cremation Creek Spring		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.08345	-112.0697111	03-Jun-95	04-Jun-95
459	Lonetree at Lone Cottonwood		South Buffer	Grand Canyon - South Rim	Below regional	Spring	36.07425	-112.0407	19-Oct-06	19-Nov-07
470	Burro Spring below Tonto Trail		South Buffer	Grand Canyon - South Rim	Below regional	Spring stream	36.076970284	-112.102883686	22-May-00	06-May-08
471	Orphan Lode Mine Adit	A-31-02 14B	South Buffer	Grand Canyon - South Rim	Mine seepage	Shaft	36.07258	-112.14976	16-May-85	16-May-85
472	Pipe Creek; lower Bright Angel (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0675159426	-112.099183347	22-Sep-94	30-Dec-08
473	Garden Creek blw Indian Garden nr Grand Canyon, AZ		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0833161	-112.1243359	23-Sep-94	19-Apr-97
474	Hermit Creek at gage		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.080597227	-112.214152776	27-Sep-94	12-Nov-08

Project Site ID	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records
409	70	316.55	228.2625	4				0				0
410	157	360	265.3333333333	3				0				0
411	277	1829	571.7	9				0				0
412	216	216	216	1	12.1	13.7	12.8	3				0
413	270	380.25	307.2625	4				0				0
443	177	345	238.775	28	1	5	3.8	10				0
444				0				0				0
446				0	54	54	54	1				0
451	309.4	309.4	309.4	1				0				0
452	345.15	345.15	345.15	1				0				0
453	330	1235	728.7777777778	9				0				0
454	320	898	604.6666666667	3				0				0
455	401	999	661.86	5				0				0
456	523	647	583.25	4				0				0
457	346.45	989	604.43	5				0				0
458	394	1072	733	2				0				0
459	827	951	883.6	5				0				0
470	275	438	351.7038461538	13				0				0
471				0	90	90	90	1	20	20	20	1
472	248	356	300.5833333333	12				0				0
473				0				0				0
474	166	276	206.6153846154	13				0				0

Project Site ID	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
409	1.9010974137	4	2.4493589007	4	3	359.06496	181.03248	2
410	2.2	2.2	2.2	1	5	5	5	1
411	3.9	3.9	3.9	1	0	3.69	1.03875	4
412	1.95015794	5.29	3.6712716457	5	314	314	314	1
413	7.0637760947	7.267353054	7.1655645743	2	44.88312	44.88312	44.88312	1
443	1.8	19	4.4230981619	14	37.8	300	56.8924703846	26
444	6	6	6	1				0
446	4.8	4.8	4.8	1				0
451	1.750890053	1.9221313922	1.8527915026	3	4.488312	4.488312	4.488312	1
452				0				0
453	4.9	4.9	4.9	1	0	15.8	2.6037196434	7
454	8.1	8.1	8.1	1	0.877	0.877	0.877	1
455	18	18	18	1	0	3.949704	0.6173524417	10
456	5.7	5.7	5.7	1	0	5.77	1.154	5
457	11.1	11.1	11.1	1	5	53.859744	29.429872	2
458	8.9666666667	8.9666666667	8.9666666667	1				0
459				0	0.5	0.5	0.5	1
470	2.4419868442	2.6563903904	2.5273888909	3	0.077	15.8	5.0189938102	11
471	620	620	620	1				0
472	2.2968520305	2.7499244275	2.4750620095	3	3.8	71.3641608	12.0517115234	47
473				0	251.345472	1018.846824	699.6779706667	18
474				0	179.53248	528.72174	317.7115835775	71

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
475	Monument Creek at Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0818938	-112.1862363	18-Nov-01	28-Nov-07	424	580	508.4285714286	7				0				0				0	22.8903912	87	45.3501698667	30
476	Indian Garden Creek; 600' Upstream from Mixing Confluence site		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.092778	-112.111389	15-Jul-02	29-Jul-02				0				0				0	1.4	1.6	1.5	2				0
477	Confluence of unnamed crystalline core stream and Garden Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0941	-112.11194	15-Jul-02	29-Jul-02				0				0				0	1.9	2.4	2.15	2				0
478	Pipe Creek basin; exposed, remote point directly above 100' waterfall		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.08848	-112.11283	29-Jul-02	29-Jul-02				0				0				0	1.8	1.8	1.8	1				0
479	Pipe Creek; 0.8 miles upstream from mixing confluence in Pipe Creek		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.08495	-112.10861	15-Jul-02	29-Jul-02				0				0				0	19	23	21	2				0
480	Salt Creek at the Tonto Trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0849333	-112.1626083	19-Mar-95	13-Nov-08	201	811	605.4166666667	12				0				0	14.7	14.7	14.7	1	0.3	61.04088	9.1237613745	10
481	Boulder Canyon above the Tonto trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.056906141	-112.036262236	15-Dec-04	30-Dec-09	564	853	647.5714285714	7				0				0				0	0	10	1.921730023	7
482	Boucher near Tonto Trail/ Campsites		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.106472898	-112.239983348	29-Mar-06	29-Mar-06	318	318	318	1				0				0				0				0
483	Grapevine Canyon at Tonto trail		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.036281832	-112.022078227	14-Dec-04	05-Nov-08	248	294	270.2	5				0				0				0	0	25	7.3951326959	7
484	Horn Creek at Phone (or power) lines		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0785692	-112.1432629	22-May-00	14-Nov-08	281	470	361.5	8				0				0	8.6343786643	29.2134786504	15.7303896787	3	0	12.2	2.4215150912	8
485	Monument Creek at Monument		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0844444	-112.1886111	04-Mar-08	12-Nov-08	563	627	595	2				0				0				0	55.1	55.1	55.1	1
486	Cottonwood Creek No. 1; lower Bright Angel alluvium		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.022599929	-111.986669592	25-May-00	09-Apr-01				0				0				0	1.4963480637	1.6035053798	1.5499267218	2				0
487	Monument Creek No. 1; Tapeats (alluvium)		South Buffer	Grand Canyon - South Rim	N/A	Stream	36.0800700272	-112.185485369	24-May-00	24-May-00				0				0				0	7.1335066096	7.1335066096	7.1335066096	1				0
489			South Buffer	Coconino Plateau - East	N/D	Well	35.958084792	-112.395732047	27-Oct-77	27-Oct-77				0	237.3	237.3	237.3	1				0	3.12	3.12	3.12	1				0
490	03 98-07.70X09.60			Cameron, AZ	Mesozoic	Spring	35.86166216	-111.3959763	19-Dec-91	19-Dec-91	361.4	361.4	361.4	1				0	5	5	5	1				0				0
492	03-098 08.13X09.52			Cameron, AZ	Mesozoic	Spring	35.86138438	-111.3959763	17-Oct-01	17-Oct-01	376.35	376.35	376.35	1				0				0				0	0.13	0.13	0.13	1
494	Wupatki Spring; A-25-10 30BBC	A-25-10 30BBC		Coconino Plateau - East	Mesozoic	Spring	35.521670551	-111.375983183	21-Oct-54	22-Oct-54	1030	1030	1030	1				0				0				0	0.12	0.12	0.12	1
495	A-25-10 32BDB	A-25-10 32BDB		Coconino Plateau - East	Mesozoic	Spring	35.50583715	-111.3545937	31-Jan-66	03-May-02	578	650	606.5	4	1.2	1.6	1.4	2	0.06	0.1	0.08	2	4.68	4.69	4.685	2				0
497				Coconino Plateau - West	Mesozoic	Spring	35.563596743	-112.585234644	18-Oct-77	18-Oct-77				0				0				0	1.49	1.49	1.49	1				0
498				Coconino Plateau - West	Mesozoic	Spring	35.641493416	-112.687238785	19-Oct-77	19-Oct-77				0	105.6	105.6	105.6	1				0	1.79	1.79	1.79	1				0
499	Ambush Spring #1; B-31-11 22BD	B-31-11 22BD		Grand Canyon - West	Mesozoic	Spring	36.07178	-113.45886	18-Jun-00	18-Jun-00	107	107	107	1				0				0				0	0	0	0	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
500	Ambush Spring #2; B-31-11 22CA	B-31-11 22CA		Grand Canyon - West	Mesozoic	Spring	36.07069	-113.45859	18-Jun-00	18-Jun-00	102	102	102	1				0				0				0	0	0	0	1
501	Russell Spring; B-36-10 13BCC	B-36-10 13BCC		Hurricane Valley	Mesozoic	Spring	36.522203339	-113.325778085	21-Jul-51	21-Jul-51				0				0				0				0	1	1	1	1
502				Hurricane Valley	Mesozoic	Spring	36.945983511	-113.35568342	06-May-79	06-May-79				0				0				0	22.22	22.22	22.22	1				0
503	Coyote Spring; B-41-10 22CDB	B-41-10 22CDB		Hurricane Valley	Mesozoic	Spring	36.93639	-113.36496	01-Jul-85	01-Jul-85	1332.5	1332.5	1332.5	1				0				0				0	1	1	1	1
504	Russel Spring; B-36-10 13CA	B-36-10 13CA		Hurricane Valley	Mesozoic	Spring	36.52015	-113.31962	01-Jul-85	01-Jul-85	1495	1495	1495	1				0				0				0				0
522	Four Mile Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring	36.87511111	-111.5071111	02-Mar-95	01-May-95				0				0				0	0.92	1	0.96	2				0
523	Power Lines Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring	36.92697222	-111.4921111	20-Oct-94	01-May-95				0	12	13	12.3333333333	3				0	1.1	1.1	1.1	3				0
524	Sewage Ponds Spring (Below Dam)			Lake Powell Vicinity	Mesozoic	Spring	36.91180556	-111.4783056	20-Oct-94	01-May-95				0				0				0	2.6	2.8	2.7333333333	3				0
525	Cottonwood Spring; B-42-06 34DDD	B-42-06 34DDD		Moccasin Mtns	Mesozoic	Spring	36.9908	-112.92097	14-May-79	07-Aug-84	273	273	273	1				0				0	0.407	0.407	0.407	1	3.8	3.8	3.8	1
526	Finnicum Seeps; B-41-06 01AC	B-41-06 01AC		Moccasin Mtns	Mesozoic	Spring	36.98464	-112.89053	01-Jul-85	01-Jul-85				0				0				0				0	0.3	0.3	0.3	1
528	Parashont Spring; B-41-05 09DB	B-41-05 09DB		Moccasin Mtns	Mesozoic	Spring	36.96724	-112.83546	01-Jul-85	01-Jul-85	204.75	204.75	204.75	1				0				0				0	1.8	1.8	1.8	1
529	Stateline Spring; B-42-06 35BA	B-42-06 35BA		Moccasin Mtns	Mesozoic	Spring	36.99672	-112.90543	07-Aug-84	07-Aug-84				0				0				0				0	4.3	4.3	4.3	1
530	Maidenhair Spring; B-42-06 35AB	B-42-06 35AB		Moccasin Mtns	Mesozoic	Spring	36.99936	-112.9098	08-Jul-84	08-Jul-84				0				0				0				0	3.9	3.9	3.9	1
531	03 078-04.75X07.27			Painted Desert	Mesozoic	Spring	36.1444362	-111.3354195	25-Feb-48	25-Feb-48	135	135	135	1				0				0				0				0
532	Sand Spring; A-42-04 32C	A-42-04 32C		Paria Plateau	Mesozoic	Spring	36.99764	-111.99389	01-Jul-85	01-Jul-85				0				0				0				0	2.5	2.5	2.5	1
533	Bush Head Canyon; A-41-06 23DA	A-41-06 23DA		Paria Plateau	Mesozoic	Spring	36.93845	-111.71227	01-Jul-85	01-Jul-85				0				0				0				0	6	6	6	1
534	Last Springs; A-41-06 15DD	A-41-06 15DD		Paria Plateau	Mesozoic	Spring	36.94897	-111.73122	01-Jul-85	01-Jul-85				0				0				0				0	4.5	4.5	4.5	1
536	Wrather Spring; A-41-06 08CC	A-41-06 08CC		Paria Plateau	Mesozoic	Spring	36.96255	-111.77967	01-Jul-85	01-Jul-85				0				0				0				0	4	4	4	1
538	A-41-07 34B (seep)	A-41-07 34B		Paria Plateau	Mesozoic	Spring	36.91434	-111.63406	06-Apr-82	06-Apr-82				0				0				0				0	9	9	9	1
539	Green Spring; B-31-11 09CD	B-31-11 09CD		Shivwits Plateau	Mesozoic	Spring	36.09415	-113.47441	18-Jun-00	14-Aug-01	327	343	335	2				0				0				0	4	5	4.5	2
541	Poverty Spring; B-35-12 26DC	B-35-12 26DC		Shivwits Plateau	Mesozoic	Spring	36.39852	-113.54803	08-Sep-76	16-Jun-00	454	537	495.5	2				0				0				0	0	1	0.5333333333	3
542				Shivwits Plateau	Mesozoic	Spring	36.225259308	-113.554383554	15-Mar-81	15-Mar-81				0				0				0	2.8	2.8	2.8	1				0
543				Shivwits Plateau	Mesozoic	Spring	36.230814765	-113.559105995	15-Mar-81	15-Mar-81				0				0				0	4.8	4.8	4.8	1				0
544				Shivwits Plateau	Mesozoic	Spring	36.145260392	-113.48799177	15-Mar-81	15-Mar-81				0				0				0	0.16	0.16	0.16	1				0
545				Shivwits Plateau	Mesozoic	Spring	36.224147912	-113.535771535	15-Mar-81	15-Mar-81				0				0				0	0.16	0.16	0.16	1				0
546				Shivwits Plateau	Mesozoic	Spring	36.246924441	-113.501325446	15-Mar-81	15-Mar-81				0				0				0	2.6	2.6	2.6	1				0
547				Shivwits Plateau	Mesozoic	Spring	36.382780368	-113.462575645	14-May-79	14-May-79				0				0				0	4.218	4.218	4.218	1				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
548	Dewdrop Spring; B-35-12 36BA	B-35-12 36BA		Shivwits Plateau	Mesozoic	Spring	36.39472	-113.53114	08-May-85	16-Jun-00				0				0				0				0	0	1.7	0.85	2
549	Salt Spring; B-34-11 06CD	B-34-11 06CD		Shivwits Plateau	Mesozoic	Spring	36.37146	-113.51327	01-Jul-85	16-Jun-00	2861	2861	2861	1				0				0				0	0	0.1	0.05	2
550	Deer Creek new river; B-35-02 28D	B-35-02 28D		Shivwits Plateau	Mesozoic	Spring	36.38853	-113.50917	03-Apr-01	03-Apr-01	218	218	218	1				0				0				0	3.9	3.9	3.9	1
551	New Spring; B-35-11 20DB	B-35-11 20DB		Shivwits Plateau	Mesozoic	Spring	36.41674	-113.49562	07-May-85	07-May-85				0				0				0				0	4.5	4.5	4.5	1
553	Andrus Lower Spring; B-33-11 20CA	B-33-11 20CA		Shivwits Plateau	Mesozoic	Spring	36.24286	-113.50366	01-Jul-85	01-Jul-85				0				0				0				0	0.2	0.2	0.2	1
554	Andrus Upper Spring; B-33-11 20CA	B-33-11 20CA		Shivwits Plateau	Mesozoic	Spring	36.24424	-113.50365	01-Jul-85	01-Jul-85				0				0				0				0	1.2	1.2	1.2	1
557	Lost Spring; B-41-07 16CDD	B-41-07 16CDD		Uinkaret Plateau - North	Mesozoic	Spring	36.948317453	-113.056328745	11-Aug-76	01-Jul-85	396.5	546	471.25	2				0				0	1.158	1.158	1.158	1	1.2	1.2	1.2	1
558				Uinkaret Plateau - North	Mesozoic	Spring	36.931184475	-113.123975451	10-May-79	10-May-79				0				0				0	16.7	16.7	16.7	1				0
559	Lytle Spring; B-41-08 29CD	B-41-08 29CD		Uinkaret Plateau - North	Mesozoic	Spring	36.91897	-113.185	01-Jul-85	01-Jul-85				0				0				0				0	0.4	0.4	0.4	1
560	Upper Lytle Spring; B-41-09 25ACA	B-41-09 25ACA		Uinkaret Plateau - North	Mesozoic	Spring	36.92798	-113.21443	01-Jul-85	01-Jul-85				0				0				0				0	0.19	0.19	0.19	1
561	Wells Spring; B-41-08 11DDB	B-41-08 11DDB		Uinkaret Plateau - North	Mesozoic	Spring	36.96393	-113.12226	01-Jul-85	01-Jul-85				0				0				0				0	0.5	0.5	0.5	1
562	Cottonwood Spring; B-41-09 25BA	B-41-09 25BA		Uinkaret Plateau - North	Mesozoic	Spring	36.9321	-113.21923	01-Jul-85	01-Jul-85				0				0				0				0	15	15	15	1
564	Little Spring; B-34-08 16DAC	B-34-08 16DAC		Uinkaret Plateau - South	Mesozoic	Spring	36.343870153	-113.151043857	16-Aug-50	01-Jul-85	890.5	890.5	890.5	1				0				0				0	1	2	1.5	2
565	Big Spring; B-34-08 19ABC	B-34-08 19ABC		Uinkaret Plateau - South	Mesozoic	Spring	36.337203071	-113.191045475	07-Aug-51	16-May-79	293.15	323	308.075	2				0				0	1.064	1.064	1.064	1	2	2	2	1
566	Death Valley Spring; B-34-09 04DB	B-34-09 04DB		Uinkaret Plateau - South	Mesozoic	Spring	36.37306	-113.26194	18-May-79	19-Jun-00				0				0				0	1.486	1.486	1.486	1	0	0	0	1
567	Cold Spring; B-34-09 09CDA	B-34-09 09CDA		Uinkaret Plateau - South	Mesozoic	Spring	36.35693	-113.26422	01-Jul-85	19-Jun-00	121	121	121	1				0				0				0	0.25	0.4	0.325	2
568	Mount Trumbull Basalt Spring; B-34-08 04BB	B-34-08 04BB		Uinkaret Plateau - South	Mesozoic	Spring	36.37893	-113.16181	20-Jun-00	20-Jun-00				0				0				0				0	0	0	0	1
571	Sawmill Tank Spring; B-34-09 12BB	B-34-09 12BB		Uinkaret Plateau - South	Mesozoic	Spring	36.36762	-113.21478	01-Jul-85	01-Jul-85				0				0				0				0	0	0	0	1
573				Virgin River Valley	Mesozoic	Spring	37.008383093	-113.412784061	19-Jun-80	19-Jun-80				0				0				0	0.001	0.001	0.001	1				0
574	Mokaac Spring; B-40-12 04AE	B-40-12 04AE		Virgin River Valley	Mesozoic	Spring	36.89889	-113.58257	01-Jul-85	01-Jul-85				0				0				0				0	4.2	4.2	4.2	1
575	Lizard Spring West; B-41-12 28BB	B-41-12 28BB		Virgin River Valley	Mesozoic	Spring	36.92903	-113.60824	05-Apr-85	01-Jul-85	1462.5	1462.5	1462.5	2				0				0				0	3	3.4	3.2	2
576	Oak Spring; B-39-12 04AB	B-39-12 04AB		Wolf Hole Mnt Vicinity	Mesozoic	Spring	36.81695	-113.58645	06-Jun-85	21-Jun-00				0				0				0				0	0.02	0.1	0.06	2
577	Wolf Hole Spring; B-39-12 21BD	B-39-12 21BD		Wolf Hole Mnt Vicinity	Mesozoic	Spring	36.76805	-113.5939	03-Jun-88	03-Jun-88	1140.75	1140.75	1140.75	1				0				0				0	0.7	0.7	0.7	1
578	Tombstone Spring; B-39-12 30BA	B-39-12 30BA		Wolf Hole Mnt Vicinity	Mesozoic	Spring	36.75694	-113.6282	01-Aug-86	01-Aug-86	1696.5	1696.5	1696.5	1				0				0				0	0.1	0.1	0.1	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
580	Canyon Spring; B-40-11 17BD	B-40-11 17BD		Wolf Hole Mnt Vicinity	Mesozoic	Spring	36.86845	-113.50252	01-Jul-85	01-Jul-85				0				0				0				0	2	2	2	1
581	Seep Spring; B-40-11 17CA	B-40-11 17CA		Wolf Hole Mnt Vicinity	Mesozoic	Spring	36.86711	-113.5015	01-Jul-85	01-Jul-85				0				0				0				0	0.8	0.8	0.8	1
582	Seegmiller Spring; B-40-11 17DD	B-40-11 17DD		Wolf Hole Mnt Vicinity	Mesozoic	Spring	36.86141	-113.49514	01-Jul-85	01-Jul-85				0				0				0				0	1	1	1	1
586	03 098-06.07X11.16			Cameron, AZ	Mesozoic	Well	35.83832927	-111.3584763	26-Jan-68	20-Dec-91	1190	2717	1953.5	2				0	40	40	40	1				0				0
587	03 098-06.72X09.34			Cameron, AZ	Mesozoic	Well	35.8644399	-111.3706982	17-Feb-55	17-Feb-55	1600	1600	1600	1				0				0				0				0
590	03 098-08.11X04.09			Cameron, AZ	Mesozoic	Well	35.9408273	-111.3954195	09-Jul-63	09-Jul-63	12600	12600	12600	1				0				0				0				0
591	03 098-08.46X07.21			Cameron, AZ	Mesozoic	Well	35.9002725	-111.403198	19-Dec-91	19-Dec-91	663	663	663	1				0	5	5	5	1				0				0
592	03 098-08.50X07.10			Cameron, AZ	Mesozoic	Well	35.89693925	-111.4018092	11-Jul-63	11-Jul-63	618	618	618	1				0				0				0				0
594	03 098-09.15X08.69			Cameron, AZ	Mesozoic	Well	35.87416189	-111.4140319	19-Aug-49	19-Aug-49	567	567	567	1				0				0				0				0
596	03 098-09.30X08.52			Cameron, AZ	Mesozoic	Well	35.87666184	-111.4145874	04-Sep-79	04-Sep-79	913	913	913	1				0				0				0				0
597	03 098-10.74X09.85			Cameron, AZ	Mesozoic	Well	35.85693998	-111.4418103	01-Jul-58	01-Jul-58	432	432	432	1				0				0				0				0
598	03 098-11.17X10.05			Cameron, AZ	Mesozoic	Well	35.85332894	-111.4495882	17-Nov-63	17-Nov-63	772	772	772	1				0				0				0				0
600	03 098-11.95X10.89			Cameron, AZ	Mesozoic	Well	35.8416625	-111.4637552	23-Jan-64	23-Jan-64	358	358	358	1				0				0				0				0
602	A-27-10 06ABC	A-27-10 06ABC		Cameron, AZ	Mesozoic	Well	35.75499739	-111.366811	10-Nov-66	10-Nov-66	766	766	766	1				0				0				0				0
604	A-26-10 16ABA	A-26-10 16ABA		Coconino Plateau - East	Mesozoic	Well	35.64000017	-111.3293128	14-Jun-79	14-Jun-79	11700	11700	11700	1				0				0				0				0
618	01 043-11.37X09.16			Kaibito Plateau	Mesozoic	Well	36.6172128	-111.4551512	25-Aug-54	25-Aug-54	131.95	131.95	131.95	1				0				0				0				0
623	01-043-09.82X14.66			Kaibito Plateau	Mesozoic	Well	36.5374909	-111.4273718	28-Aug-51	28-Aug-51	139	139	139	1				0				0				0				0
627	01-044-00.30X10.80			Kaibito Plateau	Mesozoic	Well	36.59360088	-111.5057078	01-Jul-56	01-Jul-56	205.4	205.4	205.4	1				0				0				0				0
628	01-044-01.53X07.84			Kaibito Plateau	Mesozoic	Well	36.63610066	-111.5290427	04-Apr-65	04-Apr-65	752	752	752	1				0				0				0				0
632	01-060-03.49X03.78			Kaibito Plateau	Mesozoic	Well	36.4452701	-111.3137569	22-Mar-50	22-Mar-50	392	392	392	1				0				0				0				0
633	01-060-09.15X01.85			Kaibito Plateau	Mesozoic	Well	36.4733242	-111.4154262	15-Jul-54	15-Jul-54	135	135	135	1				0				0				0				0
634	01-060-09.31X07.30			Kaibito Plateau	Mesozoic	Well	36.394157	-111.4179249	14-Jul-54	14-Jul-54	144	144	144	1				0				0				0				0
639	03 060-09.22X12.71			Kaibito Plateau	Mesozoic	Well	36.3155454	-111.4162569	14-Jan-54	14-Jan-54	145	145	145	1				0				0				0				0
651	01-028-04.93X12.74			Lake Powell Vicinity	Mesozoic	Well	36.81610298	-111.3387616	10-Mar-54	10-Mar-54	150	150	150	1				0				0				0				0
652	01-028-05.90X07.90			Lake Powell Vicinity	Mesozoic	Well	36.8852685	-111.357097	22-Jul-66	22-Jul-66	108	108	108	1				0				0				0				0
656	A-41-08 04DDA	A-41-08 04DDA		Lake Powell Vicinity	Mesozoic	Well	36.97887599	-111.5298832	03-Mar-74	31-Aug-81	630	757	701.3333333333	3	0.8	13	8.9333333333	3				0				0				0
657	A-41-08 14BCA	A-41-08 14BCA		Lake Powell Vicinity	Mesozoic	Well	36.95637647	-111.508493	19-Oct-77	09-Jun-08	553	729	651.3125	16	2	17	9.45	6	0.08	0.5	0.23	3				0	58.348056	58.348056	58.348056	1
658	A-41-08 14BCB	A-41-08 14BCB		Lake Powell Vicinity	Mesozoic	Well	36.95720979	-111.5096042	10-Mar-58	10-Mar-58	789	789	789	1				0				0				0				0
659	A-41-08 23DAC	A-41-08 23DAC		Lake Powell Vicinity	Mesozoic	Well	36.93637687	-111.495992	10-Mar-58	29-Aug-81	97	232	164.5	2				0				0				0				0
660	A-41-08 23DCD	A-41-08 23DCD		Lake Powell Vicinity	Mesozoic	Well	36.93248797	-111.499881	10-Mar-58	28-Aug-81	152	216	184	2	33	33	33	1				0				0				0
662	A-42-08 35DAB1	A-42-08 35DAB1		Lake Powell Vicinity	Mesozoic	Well	36.997765	-111.4971048	20-Aug-58	20-Aug-58	1190	1190	1190	1				0				0				0				0
663	A-42-08 35DAB2	A-42-08 35DAB2		Lake Powell Vicinity	Mesozoic	Well	36.9963761	-111.4976603	04-Dec-58	22-Apr-81	830	1360	1132.8571428571	7	40	60	46.6666666667	3				0				0	673.2468	673.2468	673.2468	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
664	A-42-08 35DAD	A-42-08 35DAD		Lake Powell Vicinity	Mesozoic	Well	36.9958206	-111.494049	20-Aug-58	20-Aug-58	1300	1300	1300	1				0				0				0				0
665	A-42-08 35DCD	A-42-08 35DCD		Lake Powell Vicinity	Mesozoic	Well	36.9910984	-111.497938	01-Nov-76	05-Dec-77	1000	1210	1100.625	4	30	70	41.4	5				0				0				0
666	A-42-08 36CBC	A-42-08 36CBC		Lake Powell Vicinity	Mesozoic	Well	36.99498735	-111.4909934	20-Aug-58	20-Aug-58	1990	1990	1990	1				0				0				0				0
667	A-42-08 36CCC1	A-42-08 36CCC1		Lake Powell Vicinity	Mesozoic	Well	36.99137626	-111.4929378	05-Dec-58	05-Dec-58	1390	1390	1390	1				0				0				0				0
668	A-42-08 36CCC2	A-42-08 36CCC2		Lake Powell Vicinity	Mesozoic	Well	36.99165406	-111.4909933	22-May-68	05-Dec-77	525	842	648.5714285714	7	30	50	40	2				0				0				0
670				Moccasin Mtns	Mesozoic	Well	37.016984102	-112.967270302	07-Jul-80	07-Jul-80				0				0				0	0.281	0.281	0.281	1				0
671				Moccasin Mtns	Mesozoic	Well	36.99768439	-112.863966619	13-May-79	13-May-79				0				0				0	0.001	0.001	0.001	1				0
672				Moccasin Mtns	Mesozoic	Well	36.94858469	-112.863565496	13-May-79	13-May-79				0				0				0	0.001	0.001	0.001	1				0
673	03 060-11.97X13.15			Painted Desert	Mesozoic	Well	36.30915574	-111.4654244	10-Feb-55	10-Feb-55	1000	1000	1000	1				0				0				0				0
674	03 078-07.66X12.47			Painted Desert	Mesozoic	Well	36.0686032	-111.3879194	13-Jun-63	13-Jun-63	1110	1110	1110	1				0				0				0				0
675	03 078-08.37X15.55			Painted Desert	Mesozoic	Well	36.0241592	-111.4004189	27-Jun-63	27-Jun-63	1210	1210	1210	1				0				0				0				0
676	03 078-09.30X17.18			Painted Desert	Mesozoic	Well	36.00054827	-111.4168077	16-Nov-67	16-Nov-67	897	897	897	1				0				0				0				0
680	A-40-05 12DDB	A-40-05 12DDB		Paria Plateau	Mesozoic	Well	36.87693025	-111.8060022	05-Aug-76	05-Aug-76	126	126	126	1				0				0				0				0
681	A-40-05 33CBC	A-40-05 33CBC		Paria Plateau	Mesozoic	Well	36.81943105	-111.8748928	05-Aug-76	05-Aug-76	165	165	165	1				0				0				0				0
685	B-32-11 07BAC	B-32-11 07BAC		Shivwits Plateau	Mesozoic	Well	36.19109274	-113.512437	20-May-79	20-May-79				0				0				0	20.772	20.772	20.772	1				0
686	B-32-12 23DDD	B-32-12 23DDD		Shivwits Plateau	Mesozoic	Well	36.1513718	-113.5352159	18-May-79	18-May-79				0				0				0	2.392	2.392	2.392	1				0
690	B-33-12 27ADB	B-33-12 27ADB		Shivwits Plateau	Mesozoic	Well	36.23359256	-113.5618839	09-Sep-76	09-Sep-76	1100	1100	1100	1				0				0				0				0
700	B-41-06 06BAA	B-41-06 06BAA		Uinkaret Plateau - North	Mesozoic	Well	36.98803985	-112.9841038	06-Aug-76	06-Aug-76	778	778	778	1				0				0				0				0
701	B-41-06 06BAD	B-41-06 06BAD		Uinkaret Plateau - North	Mesozoic	Well	36.9872065	-112.9841038	13-Jun-89	29-Aug-01	722	1230	865.3636363636	11	1	1	1	1	1	1	1	1				0				0
711	B-41-06 22CBC	B-41-06 22CBC		Uinkaret Plateau - North	Mesozoic	Well	36.93581799	-112.9360457	04-Aug-76	04-Aug-76	349	349	349	1				0				0				0				0
718	B-41-06 24AAB	B-41-06 24AAB		Uinkaret Plateau - North	Mesozoic	Well	36.94498468	-112.8874329	03-Aug-76	03-Aug-76	251	251	251	1				0				0				0				0
722	B-41-06 27CBA	B-41-06 27CBA		Uinkaret Plateau - North	Mesozoic	Well	36.9235958	-112.9354899	04-Aug-76	04-Aug-76	1270	1270	1270	1				0				0				0				0
730	B-41-06 29ADD	B-41-06 29ADD		Uinkaret Plateau - North	Mesozoic	Well	36.9255402	-112.9560462	06-Aug-76	06-Aug-76	1320	1320	1320	1				0				0				0				0
732	B-41-07 23AAA	B-41-07 23AAA		Uinkaret Plateau - North	Mesozoic	Well	36.94665115	-113.0116042	06-May-79	06-May-79				0				0				0	14.875	14.875	14.875	1				0
733	B-41-07 23ADA	B-41-07 23ADA		Uinkaret Plateau - North	Mesozoic	Well	36.9433178	-113.0110486	12-Aug-76	12-Aug-76	1080	1080	1080	1				0				0				0				0
737	B-42-06 31CCC	B-42-06 31CCC		Uinkaret Plateau - North	Mesozoic	Well	36.9919287	-112.9904929	21-Jun-89	19-Jun-07	291	324	305.3	10	6.8	8	7.4	2	0.06	0.5	0.28	2				0				0
741				Uinkaret Plateau - North	Mesozoic	Well	37.000584288	-113.180278037	26-Jun-80	26-Jun-80				0				0				0	4.024	4.024	4.024	1				0
742				Uinkaret Plateau - North	Mesozoic	Well	36.907783501	-113.352883728	06-May-79	06-May-79				0				0				0	15.622	15.622	15.622	1				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
743				Uinkaret Plateau - North	Mesozoic	Well	36.959584381	-113.150176698	06-May-79	06-May-79				0				0				0	0.238	0.238	0.238	1				0
744				Uinkaret Plateau - North	Mesozoic	Well	36.919384449	-113.183977981	08-May-79	08-May-79				0				0				0	25.72	25.72	25.72	1				0
745				Uinkaret Plateau - North	Mesozoic	Well	36.939784367	-113.249380784	08-May-79	08-May-79				0				0				0	4.598	4.598	4.598	1				0
746				Uinkaret Plateau - North	Mesozoic	Well	36.866384467	-113.225079774	08-May-79	08-May-79				0				0				0	11.932	11.932	11.932	1				0
747				Uinkaret Plateau - North	Mesozoic	Well	36.997284304	-113.195178601	12-May-79	12-May-79				0				0				0	1.024	1.024	1.024	1				0
748				Uinkaret Plateau - North	Mesozoic	Well	36.94948464	-112.892966574	13-May-79	13-May-79				0				0				0	7.279	7.279	7.279	1				0
749				Uinkaret Plateau - North	Mesozoic	Well	36.938284595	-112.963468928	13-May-79	13-May-79				0				0				0	12.902	12.902	12.902	1				0
752	C-43-07 16DBB1	C-43-07 16DBB1		Vermilion Cliffs (UT)	Mesozoic	Well	37.07165147	-112.6363174	14-Jun-90	14-Jun-90	184	184	184	1	1	1	1	1	0.5	0.5	0.5	1				0	60	60	60	1
762	C-43-15 02AAA1	C-43-15 02AAA1		Virgin River Valley	Mesozoic	Well	37.08137098	-113.4960638	22-Aug-68	22-Aug-68	3200	3200	3200	1				0				0				0				0
774	C-43-15 10ACC1	C-43-15 10ACC1		Virgin River Valley	Mesozoic	Well	37.06053745	-113.5218981	18-Oct-68	18-Oct-68	4080	4080	4080	1				0				0				0				0
780	C-43-15 12CCD2	C-43-15 12CCD2		Virgin River Valley	Mesozoic	Well	37.0522045	-113.4902303	19-May-67	22-Aug-68	1982.5	3150	2823.125	4				0				0				0				0
781	C-43-15 12CDD1	C-43-15 12CDD1		Virgin River Valley	Mesozoic	Well	37.05276005	-113.4924525	02-Jun-69	02-Jun-69	3150	3150	3150	1				0				0				0				0
791	C-43-15 25CDD1	C-43-15 25CDD1		Virgin River Valley	Mesozoic	Well	37.009427	-113.4863411	14-Aug-06	14-Aug-06	2910	2910	2910	1	0.41	0.41	0.41	1				0	6.11	6.11	6.11	1				0
792	C-43-15 25DDD1	C-43-15 25DDD1		Virgin River Valley	Mesozoic	Well	37.01248259	-113.4791188	22-Aug-68	04-Aug-71	3060	3450	3255	2				0				0				0				0
793	C-43-16 12AAA1	C-43-16 12AAA1		Virgin River Valley	Mesozoic	Well	37.0647033	-113.5813453	09-Oct-68	09-Oct-68	2840.5	2840.5	2840.5	1				0				0				0				0
795				Coconino Plateau - East	Perched	Spring	35.950185077	-112.524236512	17-Oct-77	17-Oct-77				0	241.6	241.6	241.6	1				0	3.09	3.09	3.09	1				0
796	Upper Pine Spring; B-28-08 32ADA	B-28-08 32ADA		Coconino Plateau - West	Perched	Spring	35.8422095	-113.1138136	01-Jun-82	01-Jun-82				0	20	20	20	1				0	1.6	1.6	1.6	1				0
797	Hockey Puck Spring; B-30-08 31DCD	B-30-08 31DCD		Coconino Plateau - West	Perched	Spring	35.933596715	-113.176038225	03-Sep-77	01-Jun-82				0	90.36	90.36	90.36	1				0	1.99	2.2	2.095	2				0
798	Big Spring; B-30-09 11 UNSUR-VEYED	B-30-09 11		Coconino Plateau - West	Perched	Spring	35.99970668	-113.2082618	01-Jun-82	20-May-93	447	447	447	1	2	2	2	1	5	5	5	1	2.6	4	3.3	2	4.488312	4.488312	4.488312	1
799	Beecher Spring; B-31-08 18BAD	B-31-08 18BAD		Coconino Plateau - West	Perched	Spring	36.0763721	-113.1804841	01-Jun-82	20-May-93	610	610	610	1	5	5	5	1	5	5	5	1	8	9.5	8.75	2	0	0	0	1
800	Pine Springs; B-28-08 02DDB	B-28-08 02DDB		Coconino Plateau - West	Perched	Spring	35.836931375	-113.098535487	01-Jun-82	21-Jun-84	315.25	315.25	315.25	1	10	10	10	1				0	1.8	1.8	1.8	1				0
801	Pocomate Springs			Coconino Plateau - West	Perched	Spring	35.82193229	-113.161592833	08-Jan-78	01-Jun-82				0				0				0	1.91	2	1.955	2				0
802	Unnamed spring 1/3 mile from Pine Tank			Coconino Plateau - West	Perched	Spring	35.839709529	-113.103813273	01-Jun-82	01-Jun-82				0				0				0	1.4	1.4	1.4	1				0
803	Red Spring			Coconino Plateau - West	Perched	Spring	36.070538166	-113.023811786	01-Jun-82	01-Jun-82				0				0				0	1.7	1.7	1.7	1				0
804	Moss Spring			Coconino Plateau - West	Perched	Spring	36.061649367	-113.027700641	01-Jun-82	01-Jun-82				0				0				0	1.1	1.1	1.1	1				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
805	Pocomate Springs			Coconino Plateau - West	Perched	Spring	35.823598952	-113.160481702	01-Jun-82	01-Jun-82				0				0				0	1.5	1.5	1.5	1				0
806	B-32-07 26DBA	B-32-07 26DBA		Grand Canyon - Central	Perched	Spring	36.12887086	-112.9982558	10-Dec-94	10-Dec-94	558.35	558.35	558.35	1				0				0				0				0
807	Cement Tank Spring; B-32-07 30DAD	B-32-07 30DAD		Grand Canyon - Central	Perched	Spring	36.1258155	-113.0668694	27-May-79	20-May-93	696	696	696	1	5	5	5	1	5	5	5	1	1.013	1.013	1.013	1	0	0	0	1
808	Saddle Horse Spring; B-33-07 28C	B-33-07 28C		Grand Canyon - Central	Perched	Spring	36.2291481	-113.05548098	09-Aug-76	01-Dec-05	262	328.25	295.0625	4				0				0	0.52	0.56	0.5433333333	3	0.05	1	0.3666666667	3
809	Honga Above the Mouth; B-33-07 33 UNSUR-VEYED	B-33-07 33		Grand Canyon - Central	Perched	Spring	36.21025907	-113.0499252	02-Jul-93	10-Oct-93	1280.5	1620	1450.25	2	2	2	2	1	5	5	5	1	13	13	13	1	2.244156	4.488312	3.366234	2
810	Hells Hollow Spring			Grand Canyon - Central	Perched	Spring	36.144982092	-113.109926891	01-Jun-82	01-Jun-82				0				0				0	0.9	0.9	0.9	1				0
811	Horsehair Spring			Grand Canyon - Central	Perched	Spring	36.156926608	-112.915753276	01-Jun-82	01-Jun-82				0				0				0	13	13	13	1				0
812	Saddle Horse Spring (North); B-33-07 28BC	B-33-07 28BC		Grand Canyon - Central	Perched	Spring	36.23439	-113.05682	20-Jun-00	20-Jun-00				0				0				0				0	0	0	0	1
815	Cliff Dweller Spring; A-32-03 03A	A-32-03 03A		Grand Canyon - North Rim	Perched	Spring	36.205815586	-112.061835595	01-Jun-75	09-Jul-08	280	280	280	1				0				0				0	2.2	3.1	2.7666666667	3
816	Sprayfield Spring; A-33-03 34B	A-33-03 34B		Grand Canyon - North Rim	Perched	Spring	36.217204457	-112.06878091	01-Jun-75	01-Jun-75				0				0				0				0	8	8	8	1
817	South Big Spring; A-34-01 26AC	A-34-01 26AC		Grand Canyon - North Rim	Perched	Spring	36.31821	-112.26083	01-Jun-75	06-Aug-00	198	198	198	1				0				0				0	0.18	9	4.59	2
818	Greenland Spring; A-33-04 19AD	A-33-04 19AD		Grand Canyon - North Rim	Perched	Spring	36.244275727	-112.001766903	10-Jul-08	10-Jul-08				0				0				0				0	0	0	0	1
819	Cliff Spring; A-32-04 27	A-32-04 27		Grand Canyon - North Rim	Perched	Spring	36.12441	-111.95312	10-Jul-08	10-Jul-08	260	260	260	1				0				0				0	0.5	0.5	0.5	1
820	Bright Angel Spring; A-33-03 34BA	A-33-03 34BA		Grand Canyon - North Rim	Perched	Spring	36.2203	-112.06774	10-Jul-08	10-Jul-08	240	240	240	1				0				0				0	0	0	0	1
821	Wall Creek at Source			Grand Canyon - North Rim	Perched	Spring	36.165319548	-112.023197507	28-Apr-08	28-Apr-08	74	74	74	1				0				0				0				0
822	Middle Big Spring; A-34-01 26AC	A-34-01 26AC		Grand Canyon - North Rim	Perched	Spring	36.31862	-112.2595	06-Aug-00	06-Aug-00	236	236	236	1				0				0				0	0.19	0.19	0.19	1
823	North Big Spring; A-34-01 26AA	A-34-01 26AA		Grand Canyon - North Rim	Perched	Spring	36.32161	-112.2539	06-Aug-00	06-Aug-00				0				0				0				0	0	0	0	1
824	Cliff Spring; A-32-04 27C	A-32-04 27C		Grand Canyon - North Rim	Perched	Spring	36.125	-111.93333	03-Aug-00	19-Jun-01	205	209	207	2				0				0				0	0.47	0.58	0.525	2
830	Amos Spring; B-30-12 36DC	B-30-12 36DC		Grand Canyon - West	Perched	Spring	35.941386754	-113.527271165	16-Aug-77	16-Aug-77				0				0				0	0.68	0.68	0.68	1				0
840	Shultz Spring; B-32-09 18B	B-32-09 18B		Grand Canyon - West	Perched	Spring	36.17508	-113.30171	01-Jul-85	01-Jul-85				0				0				0				0	5	5	5	1
845	Sowats Spring A; B-36-02 12DB	B-36-02 12DB		Jumpup Canyon	Perched	Spring	36.53101	-112.45519	01-Jul-00	01-Jul-00	357	357	357	1				0				0				0	0.22	0.22	0.22	1
846	Sowats Spring B; B-36-02 12DC	B-36-02 12DC		Jumpup Canyon	Perched	Spring	36.52783	-112.45501	01-Jul-00	01-Jul-00	526	526	526	1				0				0				0	1.48	1.48	1.48	1
847	Sowats Spring; B-36-02 13AA	B-36-02 13AA		Jumpup Canyon	Perched	Spring	36.52443	-112.45532	01-Jul-00	01-Jul-00	373	373	373	1				0				0				0	3.79	3.79	3.79	1
852	Kanabownits Spring; A-33-02 05BC	A-33-02 05BC		Kaibab Plateau	Perched	Spring	36.28682	-112.21295	01-Jun-75	07-Nov-08	40	80	56.3333333333	3				0				0				0	0	10.2	4.3041666667	6

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
853	Robbers Roost Spring; A-33-03 04CC	A-33-03 04CC		Kaibab Plateau	Perched	Spring	36.28027	-112.08867	01-Jun-75	08-Jul-08	105	227.5	175.375	4				0				0	0.11	0.5	0.3466666667	3	0	673	100.3378571429	7
854	Lower Thompson Spring; A-33-03 22AD	A-33-03 22AD		Kaibab Plateau	Perched	Spring	36.24331	-112.05897	01-Jun-75	01-Jun-76				0				0				0				0	0.25	0.3	0.275	2
855	Tipover Spring; A-34-02 18AC	A-34-02 18AC		Kaibab Plateau	Perched	Spring	36.34738	-112.22354	01-Jun-75	07-Aug-00	147	147	147	1				0				0				0	0.15	0.7	0.3666666667	3
856	Mangum Spring; A-37-01 07BCB	A-37-01 07BCB		Kaibab Plateau	Perched	Spring	36.622209393	-112.340180931	08-Aug-76	08-Aug-76	233	233	233	1				0				0				0	25	25	25	1
857	Big Spring; B-37-01 13DCB	B-37-01 13DCB		Kaibab Plateau	Perched	Spring	36.601930826	-112.348514901	08-Aug-76	22-Jun-01	176	194	186	3				0				0	0.433	0.433	0.433	1	50	195	146.6666666667	3
858	Neal Spring; A-33-04 18DA	A-33-04 18DA		Kaibab Plateau	Perched	Spring	36.25701	-112.00293	03-Aug-00	03-Jun-08				0				0				0				0	0	0.01	0.005	2
859	Outlet Spring; B-33-03 29CA	B-33-03 29CA		Kaibab Plateau	Perched	Spring	36.228033951	-112.100878682	08-Jul-08	08-Jul-08	220	220	220	1				0				0				0	3	3	3	1
860	Upper Thompson Spring; A-33-03 14BC	A-33-03 14BC		Kaibab Plateau	Perched	Spring	36.25937	-112.0558	03-Aug-00	10-Jul-08	197	197	197	1				0				0				0	0.1	0.12	0.11	2
861	Mangum Springs A; B-37-01 12AA	B-37-01 12AA		Kaibab Plateau	Perched	Spring	36.62554	-112.34509	14-May-79	14-May-79				0				0				0	1.014	1.014	1.014	1				0
862	Castle Spring; A-37-01 19CC	A-37-01 19CC		Kaibab Plateau	Perched	Spring	36.58626	-112.34168	16-May-79	02-Jul-00	183	183	183	1				0				0	0.615	0.615	0.615	1	3.8	3.8	3.8	1
863	Spring; A-33-03 20AA	A-33-03 20AA		Kaibab Plateau	Perched	Spring	36.25085	-112.0942	05-Aug-00	05-Aug-00				0				0				0				0	0	0	0	1
864	Basin Spring; A-33-03 08CC	A-33-03 08CC		Kaibab Plateau	Perched	Spring	36.26666	-112.10759	05-Aug-00	05-Aug-00				0				0				0				0	0	0	0	1
865	Milk Creek Spring; A-33-02 12CB	A-33-02 12CB		Kaibab Plateau	Perched	Spring	36.27097	-112.1438	05-Aug-00	05-Aug-00	19	19	19	1				0				0				0	1.61	1.61	1.61	1
866	No Name spring; A-33-03 26BB	A-33-03 26BB		Kaibab Plateau	Perched	Spring	36.23396	-112.05162	02-Aug-00	02-Aug-00				0				0				0				0	0	0	0	1
867	Timp Spring; A-35-01 33DB	A-35-01 33DB		Kaibab Plateau	Perched	Spring	36.38757	-112.2953	08-Aug-00	08-Aug-00	245	245	245	1				0				0				0	1.43	1.43	1.43	1
868	Paris-sawampitts Spring; A-35-01 20CC	A-35-01 20CC		Kaibab Plateau	Perched	Spring	36.41305	-112.31705	30-Jun-00	30-Jun-00	226	226	226	1				0				0				0	0.44	0.44	0.44	1
869	Bee Spring; A-35-01 08BA	A-35-01 08BA		Kaibab Plateau	Perched	Spring	36.4505	-112.31848	30-Jun-00	30-Jun-00	280	280	280	1				0				0				0	0	0	0	1
870	Mourning Dove Spring; B-37-01 12DC	B-37-01 12DC		Kaibab Plateau	Perched	Spring	36.61659	-112.34795	02-Jul-00	02-Jul-00	221	221	221	1				0				0				0	0.82	0.82	0.82	1
871	Quaking Aspen Spring; A-34-01 03BA	A-34-01 03BA		Kaibab Plateau	Perched	Spring	36.3801	-112.28334	29-Jun-00	29-Jun-00	233	233	233	1				0				0				0	2.06	2.06	2.06	1
872	Watts Spring; A-34-01 03AB	A-34-01 03AB		Kaibab Plateau	Perched	Spring	36.37971	-112.27575	29-Jun-00	29-Jun-00	263	263	263	1				0				0				0	1.2	1.2	1.2	1
874	Upper Two Spring; A-34-01 09BA	A-34-01 09BA		Kaibab Plateau	Perched	Spring	36.36491	-112.29853	07-Aug-00	07-Aug-00	236	236	236	1				0				0				0	0	0	0	1
876	Pasture Spring; A-34-01 04BD	A-34-01 04BD		Kaibab Plateau	Perched	Spring	36.37799	-112.29821	30-Jun-00	30-Jun-00	258	258	258	1				0				0				0	0.45	0.45	0.45	1
884	Crystal Spring; A-35-03 32A	A-35-03 32A		Kaibab Plateau	Perched	Spring	36.39038	-112.09653	27-Jun-00	27-Jun-00	114	114	114	1				0				0				0	0.94	0.94	0.94	1
886	North Canyon Spring upper; A-35-03 28BBB	A-35-03 28BBB		Kaibab Plateau	Perched	Spring	36.40992	-112.08963	28-Jun-00	28-Jun-00	160	160	160	1				0				0				0	0.93	0.93	0.93	1
887	North Canyon Spring middle; A-35-03 28BDA	A-35-03 28BDA		Kaibab Plateau	Perched	Spring	36.40522	-112.08342	28-Jun-00	20-Jun-01	160	160	160	2				0				0				0	6.63	9.2	7.915	2

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
888	North Canyon Spring lower; A-35-03 28DBC	A-35-03 28DBC		Kaibab Plateau	Perched	Spring	36.40096	-112.08059	28-Jun-00	28-Jun-00	161	161	161	1				0				0				0	44	44	44	1
889	North Canyon Spring all; A-35-03 28CAC	A-35-03 28CAC		Kaibab Plateau	Perched	Spring	36.39989	-112.08578	28-Jun-00	28-Jun-00	209	209	209	1				0				0				0	110.2	110.2	110.2	1
897	Dansil Spring; B-32-11 10BA	B-32-11 10BA		Shivwits Plateau	Perched	Spring	36.19269	-113.45631	15-Mar-81	01-Jul-85				0				0				0	2.8	2.8	2.8	1	2	2	2	1
898	Mud Spring; B-32-11 02CA	B-32-11 02CA		Shivwits Plateau	Perched	Spring	36.20107	-113.44021	15-Mar-81	01-Jul-85				0				0				0	1.9	1.9	1.9	1	0.2	0.2	0.2	1
899	Grassy Spring; B-33-11 09CDD	B-33-11 09CDD		Shivwits Plateau	Perched	Spring	36.26727	-113.47855	17-May-79	17-Jun-00	2548	2548	2548	1				0				0	5.8	13.636	9.718	2	0.1	0.3	0.2	2
900	Hidden Spring; B-36-12 31CCC	B-36-12 31CCC		Shivwits Plateau	Perched	Spring	36.46979	-113.62869	01-Jul-85	15-May-00	267	267	267	1				0				0				0	3.1	5.3	4.2	2
901	Tungsten Spring; B-33-11 23AA	B-33-11 23AA		Shivwits Plateau	Perched	Spring	36.25093	-113.43504	01-Jul-85	01-Jul-85				0				0				0				0	0.5	0.5	0.5	1
908	Ruesch Spring; B-40-10 01ACC	B-40-10 01ACC		Uinkaret Plateau - North	Perched	Spring	36.896650778	-113.320226905	26-Sep-51	26-Sep-51				0				0				0				0	0.5	0.5	0.5	1
909	Antelope Spring; B-41-09 23BCB	B-41-09 23BCB		Uinkaret Plateau - North	Perched	Spring	36.943595366	-113.24466958	01-Jul-85	01-Jul-85				0				0				0				0	0.5	0.5	0.5	1
910				Uinkaret Plateau - North	Perched	Spring	36.895183839	-113.313482722	10-May-79	10-May-79				0				0				0	7.002	7.002	7.002	1				0
911	Antelope Seeps South; B-41-09 23BBC	B-41-09 23BBC		Uinkaret Plateau - North	Perched	Spring	36.94387	-113.24456	01-Jul-85	01-Jul-85				0				0				0				0	0.1	0.1	0.1	1
912	Antelope Seeps South-West; B-41-09 23BBC	B-41-09 23BBC		Uinkaret Plateau - North	Perched	Spring	36.94387	-113.24456	01-Jul-85	01-Jul-85				0				0				0				0	0.1	0.1	0.1	1
913	Water Canyon Spring; B-41-07 07DC	B-41-07 07DC		Uinkaret Plateau - North	Perched	Spring	36.96437	-113.08743	01-Jul-85	01-Jul-85	273	273	273	1				0				0				0	0.5	0.5	0.5	1
914	Cottonwood Canyon Seeps; B-41-10 25AA	B-41-10 25AA		Uinkaret Plateau - North	Perched	Spring	36.93113	-113.31961	05-Aug-85	05-Aug-85				0				0				0				0	0.1	0.1	0.1	1
915	Cottonwood Canyon Spring; B-41-09 30BB	B-41-09 30BB		Uinkaret Plateau - North	Perched	Spring	36.93117	-113.31345	07-Sep-90	07-Sep-90	1696.5	1696.5	1696.5	1				0				0				0	1	1	1	1
916	Ruesch Spring 1; B-40-10 01DB	B-40-10 01DB		Uinkaret Plateau - North	Perched	Spring	36.89514	-113.31854	01-Jan-79	01-Jan-79				0				0				0				0	0.6	0.6	0.6	1
917	Upper Ante-lope Spring; B-41-09 27ACD	B-41-09 27ACD		Uinkaret Plateau - North	Perched	Spring	36.92723	-113.25087	01-Jul-85	01-Jul-85				0				0				0				0	0.7	0.7	0.7	1
918	03 098-08.80 X 15.98			Cameron, AZ	Perched	Well	35.76694176	-111.4079224	05-Apr-55	05-Apr-55	2920	2920	2920	1				0				0				0				0
919	03 098-09.18X08.57			Cameron, AZ	Perched	Well	35.87555075	-111.4143096	02-Jan-63	02-Jan-63	1625	1625	1625	1				0				0				0				0
921	03 098-09.25 X 08.69A			Cameron, AZ	Perched	Well	35.8738841	-111.4159764	20-Apr-51	20-Apr-51	3090	3090	3090	1				0				0				0				0
922	03 098-09.96 X 10.32			Cameron, AZ	Perched	Well	35.85027346	-111.4284769	26-Nov-67	30-Aug-79	2830	3220	3003.3333333333	3				0				0				0				0
923	03 098-13.82 X 15.90			Cameron, AZ	Perched	Well	35.7680531	-111.4970899	20-Jun-58	20-Jun-58	447	447	447	1				0				0				0				0
926	A-27-09 06ADB	A-27-09 06ADB		Cameron, AZ	Perched	Well	35.75194229	-111.4693121	07-Jun-93	11-Jun-08	973	1070	999.1	10	0.5	1	0.75	4	0.14	0.5	0.2966666667	3				0				0
927	A-27-09 06DCA1	A-27-09 06DCA1		Cameron, AZ	Perched	Well	35.74499804	-111.4715345	12-May-66	12-May-66	650	650	650	1				0				0				0				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
928	A-27-09 06DCA2	A-27-09 06DCA2		Cameron, AZ	Perched	Well	35.7444425	-111.470979	12-May-66	12-May-66	588	588	588	1				0				0				0				0
929	A-27-09 07ABB1	A-27-09 07ABB1		Cameron, AZ	Perched	Well	35.74194259	-111.4770903	12-May-66	12-May-66	582	582	582	1				0				0				0				0
932	A-27-09 11DDD	A-27-09 11DDD		Cameron, AZ	Perched	Well	35.72944259	-111.3962564	12-Nov-66	12-Nov-66	4110	4110	4110	1				0				0				0				0
937	A-25-06 20BBB	A-25-06 20BBB		Coconino Plateau - East	Perched	Well	35.54055997	-111.7823799	24-Aug-78	24-Aug-78	451	451	451	1				0				0				0				0
938	A-25-06 20BDD	A-25-06 20BDD		Coconino Plateau - East	Perched	Well	35.53556027	-111.7751576	25-Jun-65	24-Aug-78	242	264.55	253.275	2				0				0				0				0
943	A-25-09 06CCD	A-25-09 06CCD		Coconino Plateau - East	Perched	Well	35.5700029	-111.4801513	25-Jan-67	25-Jan-67	622	622	622	1				0				0				0				0
944	A-25-10 30BDB	A-25-10 30BDB		Coconino Plateau - East	Perched	Well	35.52000357	-111.3723718	27-Oct-58	09-Jul-96	910	1293.5	1139.1875	8	0.5	0.5	0.5	2	15	15	15	2				0				0
946	A-26-08 01BCD	A-26-08 01BCD		Coconino Plateau - East	Perched	Well	35.6644448	-111.4979264	05-Oct-66	26-Jul-95	942	998	970	2				0				0				0				0
948	A-26-09 15DAD	A-26-09 15DAD		Coconino Plateau - East	Perched	Well	35.6316675	-111.4129257	27-Nov-67	27-Nov-67	1200	1200	1200	1				0				0				0				0
949	A-26-09 33CAD	A-26-09 33CAD		Coconino Plateau - East	Perched	Well	35.58666887	-111.4395942	27-Nov-67	27-Nov-67	495	495	495	1				0				0				0				0
950	A-26-10 09CDA	A-26-10 09CDA		Coconino Plateau - East	Perched	Well	35.6436112	-111.3334795	10-Nov-66	10-Nov-66	7750	7750	7750	1				0				0				0				0
951	A-26-10 31CBA	A-26-10 31CBA		Coconino Plateau - East	Perched	Well	35.58972396	-111.3748703	26-Oct-54	26-Oct-54	1120	1120	1120	1				0				0				0				0
955	B-25-03 03CC2	B-25-03 03CC2		Coconino Plateau - West	Perched	Well	35.57221858	-112.5951794	05-Oct-67	05-Oct-67	324	324	324	1				0				0				0				0
959	B-26-03 20BDA	B-26-03 20BDA		Coconino Plateau - West	Perched	Well	35.6277719	-112.6229589	12-Aug-86	12-Aug-86	398	398	398	1	2	2	2	1	5	5	5	1				0				0
964	Fed by Frazier well; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Well	35.79665493	-113.077978868	01-Jun-82	01-Jun-82				0				0				0	1.4	1.4	1.4	1				0
965	XI Well; Tertiary Frazier Well gravel			Coconino Plateau - West	Perched	Well	35.784432983	-113.114091123	04-Sep-77	01-Jun-82				0	100.5	100.5	100.5	1				0	2.5	2.63	2.565	2				0
966				Coconino Plateau - West	Perched	Well	36.017783595	-112.826749556	28-May-79	28-May-79				0	15	15	15	1				0	7.141	7.141	7.141	1				0
967	Unnamed well; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Well	35.835820683	-113.093257308	01-Jun-82	01-Jun-82				0	10	10	10	1				0	1.6	1.6	1.6	1				0
968	Unnamed well; Tertiary Frazier Well gravels			Coconino Plateau - West	Perched	Well	35.810265649	-113.051033619	01-Jun-82	01-Jun-82				0				0				0	1.3	1.3	1.3	1				0
970	B-33-04 22 UNSUR-VEYED	B-33-04 22 1		Havasu Creek	Perched	Well	36.2310934	-112.6929682	23-Aug-94	23-Aug-94	578	578	578	1	12	12	12	1	5	5	5	1	3	3	3	1	198	198	198	1
974	B-33-04 23BCC1	B-33-04 23BCC1		Havasu Creek	Perched	Well	36.2322045	-112.6893569	13-Nov-75	13-Nov-75	629	629	629	1				0				0				0				0
975	B-33-04 23BCC2	B-33-04 23BCC2		Havasu Creek	Perched	Well	36.2322045	-112.6893569	23-Nov-75	23-Nov-75	622	622	622	1				0				0				0				0
983	A-34-03 09B UNSUR-VEYED	A-34-03 09B		Kaibab Plateau	Perched	Well	36.36470568	-112.0854495	07-Aug-76	07-Aug-76	65	65	65	1				0				0				0				0
989				Kaibab Plateau	Perched	Well	36.463483953	-112.246631451	24-Oct-79	24-Oct-79				0				0				0	0.024	0.024	0.024	1				0
991	PMG Well (Truxton)			Peach Springs, AZ	Perched	Well	35.496380972	-113.557162059	25-Aug-77	01-Jun-82				0	119.3	119.3	119.3	1				0	1.45	2.1	1.775	2				0
992	Truxton Well			Peach Springs, AZ	Perched	Well	35.495547855	-113.536050549	01-Jun-82	01-Jun-82				0				0				0	1.3	1.3	1.3	1				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
998	Artesian Spring at River Mile 182; B-32-08 10 UN-SURVEYED	B-32-08 10		Grand Canyon - Central	Regional	Spring	36.17359288	-113.1204832	07-Nov-90	28-May-95	841	949	889.25	4	9	9	9	1	5	5	5	1	5	5	5	1	4.488312	170.555856	62.836368	3
1000	B-32-08 22 UNSUR-VEYED	B-32-08 22		Grand Canyon - Central	Regional	Spring	36.1658152	-113.1346503	02-Jul-93	11-Oct-93	390	438.1	414.05	2	10	10	10	1	5	5	5	1	2	2	2	1	44.88312	89.76624	67.32468	2
1001	Fern Glen; B-33-06 15A	B-33-06 15A		Grand Canyon - Central	Regional	Spring	36.26244	-112.91944	08-May-76	05-Apr-01	1189.5	1232	1210.75	2				0				0	3.6	18	10.8	2	1	2	1.5	2
1002	Mohawk Can-yon; B-33-06 30 1 UNSUR-VEYED	B-33-06 30 1		Grand Canyon - Central	Regional	Spring	36.21942584	-112.9685333	09-Oct-93	06-Jan-95	1514.5	1850	1682.25	2	1	1	1	1	15	15	15	1	12	12	12	1	8.976624	8.976624	8.976624	2
1003	Mohawk Spring; B-33-06 30 2 UN-SURVEYED	B-33-06 30 2		Grand Canyon - Central	Regional	Spring	36.21442587	-112.9699222	01-Jun-82	18-Sep-01	1449.5	1449.5	1449.5	1				0				0	12	12	12	1				0
1004	Warm Spring; B-33-08 31 UNSUR-VEYED	B-33-08 31		Grand Canyon - Central	Regional	Spring	36.1966481	-113.0838153	09-May-76	07-Jan-95	819	975	886.1875	8	14	14	14	1	5	10	7.5	2	5	10.2579383035	7.6289691517	2	125.672736	6732.468	2066.867676	4
1005	Matkatamiba Spring			Grand Canyon - Central	Regional	Spring	36.3245132	-112.6598047	01-Jan-94	05-May-02	845	929.5	887.25	2				0				0				0	1	8.976624	4.8216453333	3
1006	B-34-04 13D	B-34-04 13D		Grand Canyon - Central	Regional	Spring	36.345538681	-112.671579542	07-May-76	04-Apr-01	877.5	983	930.25	2				0				0	6.4	6.4	6.4	1	2	4.14	3.07	2
1007	Tapeats Spring; B-35-01 29B	B-35-01 29B		Grand Canyon - Central	Regional	Spring	36.406926672	-112.430181362	27-Jun-51	27-Jun-51	206.7	206.7	206.7	1				0				0				0	16710	16710	16710	1
1008	Thunder Spring; B-35-02 25D	B-35-02 25D		Grand Canyon - Central	Regional	Spring	36.396093491	-112.458516308	27-Jun-51	27-Jun-51	202.15	202.15	202.15	1				0				0				0	7392	7392	7392	1
1009	B-36-06 24 UNSUR-VEYED	B-36-06 24		Grand Canyon - Central	Regional	Spring	36.2549818	-112.8782527	06-Jan-95	06-Jan-95	1215.5	1215.5	1215.5	1				0				0				0	67.32468	67.32468	67.32468	1
1010	Beecher Spring			Grand Canyon - Central	Regional	Spring	36.167222222	-113.141388889	25-Oct-07	25-Oct-07	311	311	311	1				0				0				0				0
1011	Deer Creek upper falls; B-35-02 27C	B-35-02 27C		Grand Canyon - Central	Regional	Spring	36.39978	-112.50198	03-Apr-01	02-Apr-06	177	177	177	1				0				0				0	2485	3001	2743	2
1012	Deer Creek near Upper/ Northern Source			Grand Canyon - Central	Regional	Spring	36.4013889	-112.5069444	16-Sep-05	02-Apr-06	182	191	186.5	2				0				0				0	1414	1461.88	1437.94	2
1013	Deer Creek middle source spring (calcu-lated Q)			Grand Canyon - Central	Regional	Spring	36.4002777	-112.5063888	02-Apr-06	02-Apr-06				0				0				0				0	700.176672	700.176672	700.176672	1
1014	Deer Creek Dutton spring (calculated Q)			Grand Canyon - Central	Regional	Spring	36.4016666	-112.5063888	02-Apr-06	02-Apr-06				0				0				0				0	888.685776	888.685776	888.685776	1
1015	Lava Falls (by cliff)			Grand Canyon - Central	Regional	Spring	36.196119529	-113.081302574	09-May-76	01-Jun-82				0	14	14	14	1				0	3.5	5.2	4.35	2				0
1016	Cove Canyon			Grand Canyon - Central	Regional	Spring	36.2456687725	-113.0152019877	19-May-98	19-May-98				0				0				0	11	11	11	1				0
1017	Keyhole Spring			Grand Canyon - Central	Regional	Spring	36.3795569166	-112.5823642888	11-May-98	11-May-98				0				0				0	1.7	1.7	1.7	1				0
1018	Mohawk Canyon			Grand Canyon - Central	Regional	Spring	36.2246357352	-112.9672819154	19-May-98	19-May-98				0				0				0	18	18	18	1				0
1019	River Mile 147 Seep			Grand Canyon - Central	Regional	Spring	36.3430506179	-112.675921931	17-May-98	17-May-98				0				0				0	9	9	9	1				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1020	Slimy Tick Spring			Grand Canyon - Central	Regional	Spring	36.3255843881	-112.7540595973	18-May-98	18-May-98				0				0				0	18	18	18	1				0
1021	Rampart Springs			Grand Canyon - Central	Regional	Spring	36.145009633	-113.109915787	01-Jun-82	01-Jun-82				0				0				0	1.6	1.6	1.6	1				0
1022	National Canyon Spring			Grand Canyon - Central	Regional	Spring	36.213315326	-112.879363526	01-Jun-82	01-Jun-82				0				0				0	8	8	8	1				0
1023	Warm Springs			Grand Canyon - Central	Regional	Spring	36.196952793	-113.082413734	01-Jun-82	01-Jun-82				0	14	14	14	1				0	5.4	5.4	5.4	1				0
1024	Mile 142 lower; B-35-03 27D	B-35-03 27D		Grand Canyon - Central	Regional	Spring	36.39778	-112.59897	03-Apr-01	03-Apr-01	545	545	545	1				0				0				0	0.01	0.01	0.01	1
1027	B-33-02 29 UNSURVEYED	B-33-02 29		Grand Canyon - East	Regional	Spring	36.23414765	-112.5290733	20-Jan-02	20-Jan-02	955.5	955.5	955.5	1				0				0				0	0	0	0	1
1028	HP68 Royal Arch Creek at Mouth at Elves Chasm			Grand Canyon - East	Regional	Spring	36.19525895	-112.4521255	05-May-76	19-Aug-08	362	546	427.47	7	4	4	4	1	9	9	9	1	3.5	7.3270987882	5.4135493941	2	80	417	148.8718626667	6
1029	Trilobite? Spring (below lower Fossil camp)			Grand Canyon - East	Regional	Spring	36.278109921	-112.515566508	22-Oct-07	22-Oct-07	788	788	788	1				0				0				0	2.36	2.36	2.36	1
1030	River Mile 125 Spring			Grand Canyon - East	Regional	Spring	36.2636594662	-112.5231207658	15-May-98	15-May-98				0				0				0	6.3	6.3	6.3	1				0
1031	Crytsal Spring; A-32-02 05D	A-32-02 05D		Grand Canyon - North Rim	Regional	Spring	36.19803711	-112.204895042	21-Jul-69	21-Jul-69				0				0				0				0	90	90	90	1
1032	Dragon Spring; A-32-02 09D	A-32-02 09D		Grand Canyon - North Rim	Regional	Spring	36.178592533	-112.182671314	30-Jul-69	30-Jul-69				0				0				0				0	627	627	627	1
1033	Phantom Spring; A-32-02 24D	A-32-02 24D		Grand Canyon - North Rim	Regional	Spring	36.152760225	-112.130725718	15-Aug-69	15-Aug-69				0				0				0				0	72	72	72	1
1034	Roaring Spring; A-32-03 01C	A-32-03 01C		Grand Canyon - North Rim	Regional	Spring	36.195260893	-112.036001817	11-Nov-61	01-Feb-66	144	200.85	172.425	2				0				0				0	2540	2540	2540	1
1035	Transept Spring; A-32-03 10A	A-32-03 10A		Grand Canyon - North Rim	Regional	Spring	36.190260646	-112.061835395	17-Aug-69	17-Aug-69				0				0				0				0	54	54	54	1
1036	Ribbon Spring; A-32-03 16D	A-32-03 16D		Grand Canyon - North Rim	Regional	Spring	36.169982595	-112.077113527	16-Aug-69	16-Aug-69				0				0				0				0	184	184	184	1
1037	Haunted Spring; A-32-03 19A	A-32-03 19A		Grand Canyon - North Rim	Regional	Spring	36.159704351	-112.110725273	15-Aug-69	15-Aug-69				0				0				0				0	430	430	430	1
1038	Abyss River Spring; A-33-01 02A	A-33-01 02A		Grand Canyon - North Rim	Regional	Spring	36.289702709	-112.26073029	13-Jul-69	13-Jul-69				0				0				0				0	403	403	403	1
1039	Emmett Spring; A-33-03 36A	A-33-03 36A		Grand Canyon - North Rim	Regional	Spring	36.215815939	-112.027112882	22-Jul-69	22-Jul-69				0				0				0				0	215	215	215	1
1040	Angel Spring; A-33-04 30D	A-33-04 30D		Grand Canyon - North Rim	Regional	Spring	36.222205106	-112.011001583	24-Jul-69	02-Jun-08	115	146	130.5	2				0				0				0	5413	5734.4	5573.7	2
1041	Shinumo Spring; A-34-01 33B	A-34-01 33B		Grand Canyon - North Rim	Regional	Spring	36.302202991	-112.302953982	13-Jul-69	13-Jul-69				0				0				0				0	851	851	851	1
1042	Noble Spring; A-34-01 33C	A-34-01 33C		Grand Canyon - North Rim	Regional	Spring	36.294424848	-112.299342782	13-Jul-69	13-Jul-69				0				0				0				0	54	54	54	1
1043	Roaring Springs at GRCA inlet pipe			Grand Canyon - North Rim	Regional	Spring	36.1952778	-112.035	07-Aug-07	07-Aug-07	121	121	121	1				0				0				0				0
1047	Elves Chasm Spring; A-32-02 01 UNSURVEYED	A-32-02 01		Grand Canyon - South Rim	Regional	Spring	36.18859238	-112.4549033	15-May-98	23-Mar-02	494	494	494	1				0				0	3.1	3.1	3.1	1	8.976624	8.976624	8.976624	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1050	Diamond Creek Spring (Upper Diamond Spring); B-27-09 15CDC	B-27-09 15CDC		Grand Canyon - West	Regional	Spring	35.719990029	-113.23159471	01-Jun-82	09-Jun-94	265	295.1	280.05	2	6	10	8	2	10	10	10	1	0.2	4	2.1	2	242.368848	278.275344	260.322096	2
1051	Diamond Spring; B-27-09 20ACB	B-27-09 20ACB		Grand Canyon - West	Regional	Spring	35.7133234	-113.261318	01-Jun-82	09-Dec-94	292.5	307	299.75	2	2	2	2	1	5	5	5	1	1	1.2	1.1	2	251.345472	255.833784	253.589628	2
1052	B-27-10 24ABB	B-27-10 24ABB		Grand Canyon - West	Regional	Spring	35.71721195	-113.2971527	19-May-93	09-Dec-94	329.55	695.5	569.1833333333	3				0				0				0	8.976624	139.137672	82.28572	3
1053	Blue Mountain Seep; B-27-10 25ADC	B-27-10 25ADC		Grand Canyon - West	Regional	Spring	35.69749009	-113.2940969	01-Jun-82	01-Jun-82				0				0				0	2.1	2.1	2.1	1				0
1054	Travertine Canyon Spring; B-27-11 10 UNSURVEYED	B-27-11 10		Grand Canyon - West	Regional	Spring	35.73498826	-113.4435468	15-May-93	08-Dec-94	409.5	430.3	420.9333333333	3	38	38	38	1	5	5	5	1	2	2	2	1	538.59744	897.6624	748.052	3
1055	Hindu Spring; B-27-12 20ACA	B-27-12 20ACA		Grand Canyon - West	Regional	Spring	35.71387756	-113.577996	14-Sep-77	16-May-93	447	447	447	1	3	3	3	1	5	5	5	1	0.37	1	0.685	2	125.672736	125.672736	125.672736	1
1056	Bridge Canyon Spring; B-28-12 35 UNSURVEYED	B-28-12 35		Grand Canyon - West	Regional	Spring	35.76387655	-113.526883	06-Aug-92	08-Dec-94	376	410.15	393.975	4	35	35	35	1	5	5	5	1	6	6	6	1	26.929872	215.438976	81.911694	4
1057	Granite Park Spring; B-30-10 25 UNSURVEYED	B-30-10 25 1		Grand Canyon - West	Regional	Spring	35.96387456	-113.3107647	13-Oct-93	13-Oct-93	564	564	564	1	16	16	16	1	5	5	5	1	4	4	4	1	13.464936	13.464936	13.464936	1
1059	Granite Spring Canyon; UNSURVEYEDEYED			Grand Canyon - West	Regional	Spring	35.81526579	-113.309931	19-May-93	19-May-93	542	542	542	1	5	5	5	1	5	5	5	1	1	1	1	1	58.348056	58.348056	58.348056	1
1060	Three Springs			Grand Canyon - West	Regional	Spring	35.885542513	-113.293541844	01-Jun-82	01-Jun-82				0	16	16	16	1				0	1.8	1.8	1.8	1				0
1061	River Mile 213 Spring			Grand Canyon - West	Regional	Spring	35.9185011765	-113.3358468389	21-May-98	21-May-98				0	24	24	24	1				0	3.4	3.4	3.4	1				0
1062	East Diamond Spring			Grand Canyon - West	Regional	Spring	35.718878925	-113.254651124	01-Jun-82	01-Jun-82				0				0				0	1.1	1.1	1.1	1				0
1063	Rocky Spring			Grand Canyon - West	Regional	Spring	35.749433026	-113.363821795	01-Jun-82	01-Jun-82				0	62	62	62	1				0	28	28	28	1				0
1064	Spring Canyon; B-30-10 10B	B-30-10 10B		Grand Canyon - West	Regional	Spring	36.01817	-113.35531	06-Apr-01	06-Apr-01	413	413	413	1				0				0				0	32.4	32.4	32.4	1
1068	Fern Spring; B-33-04 11 UNSURVEYED	B-33-04 11		Havasu Creek	Regional	Spring	36.25664897	-112.7018576	24-Aug-94	24-Aug-94	534	534	534	1	8	8	8	1	20	20	20	1	4	4	4	1	8	8	8	1
1069	Havasu Spring; B-33-04 26 UNSURVEYED	B-33-04 26		Havasu Creek	Regional	Spring	36.21748238	-112.6874123	16-May-85	23-Aug-94	492	650	592.8181818182	11	5	20	11.5090909091	11	20	20	20	1	4	12	6.3054545455	11	28700	28700	28700	1
1070	At Last Spring; A-33-04 03B	A-33-04 03B		Kaibab Plateau	Regional	Spring	36.287761971	-111.96322275	29-Jul-69	29-Jul-69				0				0				0				0	260	260	260	1
1071	03 079-10.39X08.30			Little Col. River	Regional	Spring	36.129154907	-111.686819359	20-Jun-51	20-Jun-51	3970	3970	3970	1				0				0				0				0
1072	03 079-10.42X09.78			Little Col. River	Regional	Spring	36.108044063	-111.687375042	16-Feb-02	16-Feb-02	3484	3484	3484	1				0				0				0				0
1073	03 079-10.69X08.97			Little Col. River	Regional	Spring	36.119431922	-111.692097442	01-Jan-66	01-Jan-66	2900	2900	2900	1				0				0				0	11250	11250	11250	1
1074	03 079-10.78X09.05			Little Col. River	Regional	Spring	36.118598915	-111.69320848	01-Jan-66	01-Jan-66	2430	2430	2430	1				0				0				0	15750	15750	15750	1
1076	Blue Spring; 03 079-10.81X09.20			Little Col. River	Regional	Spring	36.116654919	-111.694319499	14-Jun-50	16-Feb-02	2305	2619.5	2375	16	4	5	4.7272727273	11				0	1	34	7.1927272727	11	43536.6264	48000	45768.3132	2
1077	03 079-11.49X04.86			Little Col. River	Regional	Spring	36.179987335	-111.705710045	15-Mar-67	15-Mar-67				0				0				0				0	100	100	100	1
1078	03 079-11.50X04.22			Little Col. River	Regional	Spring	36.188598267	-111.706543223	15-Mar-67	15-Mar-67				0				0				0				0	50	50	50	1

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1083	Little Colorado River; 4.5 miles up from mouth; North bank			Little Col. River	Regional	Spring	36.1934945919	-111.739428957	19-Sep-82	19-Sep-82	25000	25000	25000	1	220	220	220	1				0				0	6	6	6	1
1084	03 062-04.05X16.52			Marble Canyon	Regional	Spring	36.259707611	-111.822938403	15-Jun-60	01-Sep-67	4830	4830	4830	1				0				0				0	5	5	5	1
1085	Berts Canyon			Marble Canyon	Regional	Spring	36.3980194196	-111.8858468002	11-May-98	14-Oct-07	285	285	285	1				0				0	1.4	1.4	1.4	1	0.36	0.36	0.36	1
1086	Buck Farm Spring; A-35-05 29	A-35-05 29		Marble Canyon	Regional	Spring	36.409444	-111.893333	23-Aug-09	23-Aug-09	460.2	460.2	460.2	1	1.2	1.2	1.2	1				0	2.82	2.82	2.82	1	0.59	0.59	0.59	1
1087	50-mile (Hackberry) Spring			Marble Canyon	Regional	Spring	36.335	-111.8611111	14-Oct-07	14-Oct-07	198	198	198	1				0				0				0				0
1088	Nankoweap 1-mile Spring			Marble Canyon	Regional	Spring	36.2972222	-111.8763888	15-Oct-07	15-Oct-07	378	378	378	1				0				0				0	174	174	174	1
1089	Saddle Canyon			Marble Canyon	Regional	Spring	36.3597455581	-111.9044271517	11-May-98	11-May-98				0				0				0	2.6	2.6	2.6	1				0
1090	Buck Farm; A-35-05 29B	A-35-05 29B		Marble Canyon	Regional	Spring	36.40572	-111.87918	27-Mar-01	27-Mar-01	222	222	222	1				0				0				0				0
1091	Nankoweap I mile; A-34-05 33C	A-34-05 33C		Marble Canyon	Regional	Spring	36.29313	-111.87947	27-Mar-01	27-Mar-01	416	416	416	1				0				0				0	1.68	1.68	1.68	1
1092	Saddle Canyon; A-34-05 07A	A-34-05 07A		Marble Canyon	Regional	Spring	36.37831	-111.89056	27-Mar-01	27-Mar-01	192	192	192	1				0				0				0				0
1093	Peach Springs No. 1; B-25-11 02CBC	B-25-11 02CBC		Peach Springs, AZ	Regional	Spring	35.578880265	-113.431046911	01-Jun-82	13-Jun-07	336	603	385.7352941176	17	5	6.5	5.75	2	0.06	5	2.53	2	1.6	1.6	1.6	1	70	70	70	1
1094	Peach Springs No. 2; B-25-11 03DAD	B-25-11 03DAD		Peach Springs, AZ	Regional	Spring	35.578880258	-113.431601934	10-Aug-92	31-Mar-95	367	431.6	400.6625	4	6	7	6.5	2	5	5	5	2	2	2	2	2	28.2763656	85.277928	63.10566672	5
1095	Surprise Springs; B-25-11 25DBD	B-25-11 25DBD		Peach Springs, AZ	Regional	Spring	35.51915956	-113.401323749	01-Sep-77	29-Mar-95	462.15	484.25	473.6333333333	3	168.7	168.7	168.7	1				0	0.92	1.2	1.06	2	0.05	0.05	0.05	1
1096	Metuck Springs; B-26-10 07DCD	B-26-10 07DCD		Peach Springs, AZ	Regional	Spring	35.646657044	-113.383266919	01-Jun-82	08-Jun-94	471.9	476.45	474.175	2	16	16	16	1				0	0.8	0.8	0.8	1	0	4.488312	2.244156	2
1097	Mulberry Spring; B-26-11 25ACB	B-26-11 25ACB		Peach Springs, AZ	Regional	Spring	35.61193528	-113.4035455	01-Jun-82	06-Jun-94	308.75	308.75	308.75	1	11	11	11	1				0	3.1	3.1	3.1	1	4.488312	4.488312	4.488312	1
1098	Red Spring; B-25-11 14BAA	B-25-11 14BAA		Peach Springs, AZ	Regional	Spring	35.559158683	-113.422435591	02-Sep-77	15-Jun-84	370.5	370.5	370.5	1	24	142.9	83.45	2				0	3.3	3.6	3.45	2	0.33	0.33	0.33	1
1099	Lower Peach Springs; B-26-11 34DBC	B-26-11 34DBC		Peach Springs, AZ	Regional	Spring	35.592212949	-113.439936246	14-Sep-77	15-Jun-84	416	416	416	1	145	145	145	1				0	1.09	2.6	1.845	2				0
1100	Mesquite Spring; B-26-11 02ACB	B-26-11 02ACB		Peach Springs, AZ	Regional	Spring	35.670545622	-113.421879376	15-Jun-84	15-Jun-84	715	715	715	1				0				0				0				0
1101	Mesquite Spring; Bright Angel Shale in landslide block adjacent to Hurricane Fault			Peach Springs, AZ	Regional	Spring	35.670267429	-113.421879476	01-Jun-82	01-Jun-82				0	73	73	73	1				0	21	21	21	1				0
1102	Emmett Spring at Old Bright Angel Trail			Grand Canyon - North Rim	Regional	Spring stream	36.210593969	-112.024253868	13-Sep-07	02-Jun-08	126	150	140	3				0				0				0	197.7	441	290.2	3
1103	Three Springs Canyon above the Mouth Spring; B-29-10 25 UN-SURVEYED	B-29-10 25		Grand Canyon - West	Regional	Spring stream	35.88554246	-113.3079867	18-Jul-78	26-Oct-07	309	466.05	409.6333333333	6	10	175.2	92.6	2	5	5	5	1	2	2.2	2.0966666667	3	8.976624	237.880536	116.525332	6
1104	Hindu Canyon			Grand Canyon - West	Regional	Spring stream	35.703044438	-113.57966274	01-Jun-82	01-Jun-82				0				0				0	1.8	1.8	1.8	1				0
1107	A-25-02 27ABA	A-25-02 27ABA		Coconino Plateau - East	Regional	Well	35.5261123	-112.1643325	10-Jan-70	10-Jan-70	12400	12400	12400	1				0				0				0				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1108	A-26-02 01CDD	A-26-02 01CDD		Coconino Plateau - East	Regional	Well	35.65832914	-112.1312764	13-Apr-04	13-Apr-04	491.4	491.4	491.4	1				0				0				0				0
1110	A-26-02 11DDB	A-26-02 11DDB		Coconino Plateau - East	Regional	Well	35.6452741	-112.1432211	23-May-96	18-Jun-08	496	531	507.875	8	0.11	0.5	0.2533333333	3	0.04	0.5	0.2	3				0				0
1116	B-32-04 24CDA2	B-32-04 24CDA2		Havasu Creek	Regional	Well	36.13970506	-112.6640776	01-May-02	01-May-02	1001	1001	1001	1				0				0				0				0
1120	Shipley Well; B-25-10 29BBD1	B-25-10 29BBD1		Peach Springs, AZ	Regional	Well	35.526381491	-113.374655496	01-Jun-82	01-Jun-82				0				0				0	1.1	1.1	1.1	1				0
1122	Moonshine Spring; A-32-05 16A UN-SURVEYED	A-32-05 16A		Grand Canyon - East	Below regional	Spring	36.15887434	-111.8562718	18-Mar-05	26-Mar-06	451	508	479.5	2				0				0				0	20.3	20.3	20.3	1
1123	117-mile Spring			Grand Canyon - East	Below regional	Spring	36.201707132	-112.457088556	21-Oct-07	21-Oct-07	1251	1251	1251	1				0				0				0				0
1124	Unkar (Ambush) Spring			Grand Canyon - East	Below regional	Spring	36.094390035	-111.89559985	16-Oct-07	16-Oct-07	498	498	498	1				0				0				0				0
1125	Dead Duck; A-31-05 03C	A-31-05 03C		Grand Canyon - East	Below regional	Spring	36.09503	-111.84681	28-Mar-01	28-Mar-01	2210	2210	2210	1				0				0				0	0.01	0.01	0.01	1
1126	222 Mile Canyon Springs			Grand Canyon - West	Below regional	Spring	35.80415479	-113.322987	25-Oct-92	15-Oct-93	880	1027	956.3333333333	3	6	6	6	1	5	5	5	1	29	29	29	1	2.244156	4.488312	3.74026	3
1127	Travertine Falls Spring; B-27-11 03 UNSURVEYED	B-27-11 03		Grand Canyon - West	Below regional	Spring	35.756099	-113.4474358	01-Jun-82	05-Jun-94	950	1131	1044.6666666667	3	120	200	160	2	5	5	5	1	9.5	11	10.25	2	53.859744	76.301304	65.828576	3
1129	Pumpkin Spring at River Mile 213; B-29-10 14 2 UN-SURVEYED	B-29-10 14 2		Grand Canyon - West	Below regional	Spring	35.91720866	-113.3338208	13-Oct-93	08-Jan-95	5980	8320	7150	2	15	15	15	1	1	1	1	1	17	17	17	1	2.244156	4.488312	3.366234	2
1130	Robbers Roost Spring			Grand Canyon - West	Below regional	Spring	35.718045316	-113.296319334	01-Jun-82	01-Jun-82				0	58	58	58	1				0	21	21	21	1				0
1131	River Mile 212.9, GCNP: Pumpkin Spring			Grand Canyon - West	Below regional	Spring	35.91637534	-113.3338208	11-May-76	21-May-98	7735	7735	7735	1	350	350	350	1	50	50	50	1	12	20.8089605585	15.2696535195	3				0
1132	Travertine Canyon above mouth at River Mile 228			Grand Canyon - West	Below regional	Spring	35.75082145	-113.4246572	01-Jun-82	08-Dec-94	492.7	682.5	570.38	5	59	100	79.5	2	5	5	5	1	2.9	4	3.45	2	255.833784	1077.19488	628.36368	5
1133	205.8-mile (Orchid) Spring			Grand Canyon - West	Below regional	Spring	36.000259783	-113.340607632	26-Oct-07	26-Oct-07	326.3	326.3	326.3	1				0				0				0				0
1134				Grand Canyon - West	Below regional	Spring	35.761788477	-113.362266139	14-Sep-77	14-Sep-77				0	111	111	111	1				0	7.15	7.15	7.15	1				0
1135	Seep south of Separation Canyon			Grand Canyon - West	Below regional	Spring	35.807765549	-113.566884352	01-Jun-82	01-Jun-82				0	60	60	60	1				0	18	18	18	1				0
1136	Seep south of Separation Canyon			Grand Canyon - West	Below regional	Spring	35.807765556	-113.567717684	01-Jun-82	01-Jun-82				0	61	61	61	1				0	28	28	28	1				0
1137	Nankoweap Twin Spring			Marble Canyon	Below regional	Spring	36.2817077983	-111.8889287016	12-May-98	12-May-98				0				0				0	1.5	1.5	1.5	1				0
1138	Butte Fault upper; A-33-05 05C	A-33-05 05C		Marble Canyon	Below regional	Spring	36.28231	-111.89014	27-Mar-01	27-Mar-01	381	381	381	1				0				0				0	80	80	80	1
1139	Butte Fault lower; A-33-05 05C	A-33-05 05C		Marble Canyon	Below regional	Spring	36.28231	-111.89014	27-Mar-01	27-Mar-01	385	385	385	1				0				0				0	10	10	10	1
1140	Roaring Springs below pumphouse			Grand Canyon - North Rim	Below regional	Spring stream	36.192647745	-112.032294806	17-Jul-07	15-Oct-08	109	148	133.6	5				0				0				0	1826.8	5267	2794	7
1141	Roaring Springs above main springs			Grand Canyon - North Rim	Below regional	Spring stream	36.194852381	-112.036939481	17-Jul-07	01-Jun-08	168	178	173	2				0				0				0	72	220.12	113.7962857143	7
1142	Lost Travertine Falls Spring			Grand Canyon - West	Below regional	Spring stream	35.756098609	-113.498270898	01-Jun-82	01-Jun-82				0	48	48	48	1				0	6.3	6.3	6.3	1				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1143	1/4 mile below Bridge Canyon Spring			Grand Canyon - West	Below regional	Spring stream	35.769154336	-113.527160796	01-Jun-82	01-Jun-82				0	32	32	32	1				0	4.6	4.6	4.6	1				0
1144	Little Colorado River at Cameron, AZ			Cameron, AZ	N/A	Stream	35.8777729	-111.4118096	17-May-95	17-May-95				0				0				0	9.9	9.9	9.9	1				0
1145	Kanab Creek above mouth near Supai, AZ			Grand Canyon - Central	N/A	Stream	36.39581624	-112.6318566	08-May-90	23-Oct-07	291.2	1235	728.3481481481	27				0				0				0	1539.491016	2199272.88	72001.8451603721	43
1146	National Canyon above mouth at River Mile 166.5 in Hualapai			Grand Canyon - Central	N/A	Stream	36.2549818	-112.8782527	08-Oct-93	08-Oct-93				0				0				0	4	4	4	1				0
1147	140 Mile Canyon			Grand Canyon - Central	N/A	Stream	36.3983333	-112.5683333	04-Apr-06	04-Apr-06	548	548	548	1				0				0				0	0.203	0.203	0.203	1
1148	Deer Creek Below Main Falls			Grand Canyon - Central	N/A	Stream	36.3886111	-112.5083333	15-Jul-06	15-Jul-06	183	183	183	1				0				0				0	2612	2612	2612	1
1149	Deer Creek Patio			Grand Canyon - Central	N/A	Stream	36.392244048	-112.506172694	23-Oct-07	20-Aug-08	180	191	185.5	2				0				0				0	2553	2862	2707.5	2
1150	Deer Creek below middle confluence			Grand Canyon - Central	N/A	Stream	36.3975	-112.5052778	02-Apr-06	02-Apr-06				0				0				0				0	2115	2115	2115	1
1151	Matkatamiba near River			Grand Canyon - Central	N/A	Stream	36.3422222	-112.6719444	04-Apr-06	16-Jul-06	676.7	680	678.35	2				0				0				0	59	59	59	1
1152	Olo Canyon at Waterfall			Grand Canyon - Central	N/A	Stream	36.3705555	-112.6497222	24-Oct-07	24-Oct-07	402	402	402	1				0				0				0				0
1153	Stone Creek near River below Falls			Grand Canyon - Central	N/A	Stream	36.347494717	-112.452453529	22-Mar-05	22-Oct-07	205	205	205	1				0				0				0	235	1021	571.3333333333	3
1154	Tapeats Creek near River			Grand Canyon - Central	N/A	Stream	36.371255723	-112.468749603	15-Jul-06	19-Aug-08	142.6	150	146.3	2				0				0				0	19636	19636	19636	1
1155	Tapeats above Thunder			Grand Canyon - Central	N/A	Stream	36.3933333	-112.4511111	01-Apr-06	01-Apr-06	153	153	153	1				0				0				0	21521	21521	21521	1
1156	Tapeats below Thunder			Grand Canyon - Central	N/A	Stream	36.3905556	-112.4525	01-Apr-06	01-Apr-06	152	152	152	1				0				0				0	29683	29683	29683	1
1157	Havasu Creek near mouth			Grand Canyon - Central	N/A	Stream	36.3140881049	-112.760158682	05-Nov-90	20-Jun-91				0	11.2	12	11.42	5				0	3.76	3.98	3.848	5				0
1158	Bright Angel Creek near Grand Canyon, AZ			Grand Canyon - East	N/A	Stream	36.10303836	-112.0962798	31-Dec-61	27-Aug-09	103	423.15	207.2630136986	146	1	1	1	1				0	1	1	1	1	6148.98744	186264.948	29542.4715223881	67
1159	Bright Angel Creek at mouth			Grand Canyon - East	N/A	Stream	36.0997222	-112.0938889	18-Jun-91	30-Apr-94	117	117	117	1				0				0	0.54	1.0811111111	0.6852777778	4				0
1160	Clear Creek near River			Grand Canyon - East	N/A	Stream	36.082359249	-112.035948853	27-Mar-06	17-Oct-07	176	197	186.5	2				0				0				0	828	970	899	2
1161	Crystal near River			Grand Canyon - East	N/A	Stream	36.135516398	-112.244018568	21-Mar-05	18-Aug-08	481	1186.9	835.98	5				0				0				0	200	2934.00171	1042.400342	5
1162	Shinimo Creek near River			Grand Canyon - East	N/A	Stream	36.2372222	-112.3488889	14-Jul-06	14-Jul-06				0				0				0				0	3265	3265	3265	1
1163	Shinimo Creek at Trail Xing			Grand Canyon - East	N/A	Stream	36.241096307	-112.349969132	30-Mar-06	19-Aug-08	151	172	164.6666666667	3				0				0				0	3490	5300	4395	2
1164	Shinimo Creek above Burro Canyon			Grand Canyon - East	N/A	Stream	36.244306449	-112.348293806	11-Jul-07	12-Jul-07	136	166	151	2				0				0				0	4077	4361	4219	2
1165	Shinumo Creek at WQ reference site			Grand Canyon - East	N/A	Stream	36.238868785	-112.349246447	13-Mar-09	13-Mar-09	164	164	164	1				0				0				0	6387	6387	6387	1
1166	Bright Angel Creek above Roaring confluence			Grand Canyon - North Rim	N/A	Stream	36.1933333	-112.0319444	04-Oct-07	02-Jun-08	143	148	145.5	2				0				0				0	3863.6	7855	5087.575	4

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1167	Phantom Creek at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream	36.1163888	-112.0875	18-Mar-08	18-Mar-08	221	221	221	1				0				0				0	872.6	872.6	872.6	1
1168	The Trancept at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream	36.1716666	-112.0402777	17-Mar-08	17-Mar-08	217	217	217	1				0				0				0	448.83	448.83	448.83	1
1169	Haunted Creek at Phantom Creek confluence			Grand Canyon - North Rim	N/A	Stream	36.144764668	-112.120888122	27-May-08	27-May-08	134	134	134	1				0				0				0	660.43	660.43	660.43	1
1170	Phantom Creek at Haunted Creek Confluence			Grand Canyon - North Rim	N/A	Stream	36.144887015	-112.121301121	27-May-08	27-May-08	217	217	217	1				0				0				0	60	60	60	1
1171	Ribbon Falls below lower falls			Grand Canyon - North Rim	N/A	Stream	36.1591667	-112.0552778	18-Mar-08	18-Mar-08	198	198	198	1				0				0				0	387.6	387.6	387.6	1
1172	Wall Creek at Bright Angel Creek			Grand Canyon - North Rim	N/A	Stream	36.163523415	-112.046388172	17-Mar-08	28-Apr-08	87	166	126.5	2				0				0				0	763	3647	2205	2
1173	Colorado River above Diamond Creek near Peach Spring			Grand Canyon - West	N/A	Stream	35.7735994	-113.363544	13-Mar-01	23-Nov-04				0				0				0	3.45	4.76	3.93	4				0
1174	Spring Canyon			Grand Canyon - West	N/A	Stream	36.0186111	-113.3519444	07-Apr-06	26-Oct-07	309	312	311	3				0				0				0	223	2350	943	3
1175	Spring Canyon			Grand Canyon - West	N/A	Stream	36.018337153	-113.353235966	26-Mar-05	20-Sep-05	450.281	450.281	450.281	1				0				0				0	295	692.74	493.87	2
1176				Grand Canyon - West	N/A	Stream	35.7455882	-113.425968391	18-Jul-78	18-Jul-78				0	310	310	310	1				0	2.15	2.15	2.15	1				0
1177				Grand Canyon - West	N/A	Stream	35.772487594	-113.524071767	18-Jul-78	18-Jul-78				0	178.4	178.4	178.4	1				0	5.41	5.41	5.41	1				0
1178	Mouth of Spencer Canyon; Spencer Canyon gravels			Grand Canyon - West	N/A	Stream	35.823320973	-113.567717638	01-Jun-82	01-Jun-82				0				0				0	2	2	2	1				0
1179	Sample point #25 Havasu Creek near Supai, AZ			Havasu Creek	N/A	Stream	36.21887129	-112.69241252	28-Mar-82	28-Mar-82				0	19	19	19	1				0				0				0
1180				Kaibab Plateau	N/A	Stream	36.510385145	-112.136130069	19-May-79	19-May-79				0				0				0	0.14	0.14	0.14	1				0
1181	Kanab Creek at confluence with Colorado River	B-35-03 32A		Kanab Creek - Lower	N/A	Stream	36.39214	-112.62961	15-Jan-85	16-Jul-06	573	1330	1009.6666666667	6	0.5	1	0.6	5	0.5	10	2.4	5	4.8	17.2	6.762	10	1963	1963	1963	1
1182	Little Colorado Rver above mouth near Desert View, AZ			Little Col. River	N/A	Stream	36.1952642	-111.7771024	20-Jan-90	21-Feb-10	448.5	3133	2354.3	19				0				0				0	84380.2656	1032311.76	141640.841005	48
1183	River Mile 0.1, Little Colorado River			Little Col. River	N/A	Stream	36.19248619	-111.7965476	01-May-76	19-Jun-91	1170	1170	1170	1				0	10	10	10	1	4.57	25.6	9.5280365479	5				0
1184	River Mile 3.1, Little Colorado River			Little Col. River	N/A	Stream	36.20082	-111.7576572	17-May-66	18-Nov-02	2550	3029	2656.5	6	3	3	3	1				0				0	96947.5392	101884.6824	99416.1108	2
1185	Nankoweap Creek 100 met from mouth of Colorado River, AZ			Marble Canyon	N/A	Stream	36.30470756	-111.8596075	30-Apr-76	15-Oct-07	337	429	371.6666666667	3				0	8	8	8	1	5.568595079	5.568595079	5.568595079	1	31	599	315	2
1186	Saddle Canyon			Marble Canyon	N/A	Stream	36.3597222	-111.905	14-Oct-07	14-Oct-07	191	191	191	1				0				0				0	9.1	9.1	9.1	1
1187	03 98-05.03X08.25			Cameron, AZ	N/D	Well	35.87443979	-111.3398643	05-Nov-91	05-Nov-91	1287	1287	1287	1				0	5	5	5	1				0				0
1189	JDD-1			Cameron, AZ	N/D	Well	35.90582797	-111.4009757	01-Nov-91	01-Nov-91	1605.5	1605.5	1605.5	1				0	15	15	15	1				0				0

Table G-1. Summary of Selected Chemical Quality Data for Water Samples (Continued)

Project Site ID	Site Description	Cadastral	Parcel	Area	Aquifer Type	Site Type	Latitude	Longitude	First Sample Date	Last Sample Date	Minimum TDS Concentration (mg/L)	Maximum TDS Concentration (mg/L)	Average TDS Concentration (mg/L)	TDS Concentration (mg/L) Number of Records	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Average Arsenic Concentration (µg/L)	Arsenic Concentration (µg/L) Number of Records	Minimum Lead Concentration (µg/L)	Maximum Lead Concentration (µg/L)	Average Lead Concentration (µg/L)	Lead Concentration (µg/L) Number of Records	Minimum Uranium Concentration (µg/L)	Maximum Uranium Concentration (µg/L)	Average Uranium Concentration (µg/L)	Uranium Concentration (µg/L) Number of Records	Minimum Flow Rate (gpm)	Maximum Flow Rate (gpm)	Average Flow Rate (gpm)	Flow Rate (gpm) Number of Records
1192				Coconino Plateau - East	N/D	Well	35.806188656	-112.436232269	28-Oct-77	28-Oct-77				0	125.2	125.2	125.2	1				0	1.94	1.94	1.94	1				0
1195	B-27-06 12BDB	B-27-06 12BDB		Coconino Plateau - West	N/D	Well	35.74387846	-112.8765822	11-Aug-86	11-Aug-86	2400	2400	2400	1	0.5	0.5	0.5	1	15	15	15	1				0				0
1200	B-28-07 31CBB	B-28-07 31CBB		Coconino Plateau - West	N/D	Well	35.7680444	-113.0752009	04-Sep-77	04-Sep-77				0				0				0	1.43	1.43	1.43	1				0
1203				Coconino Plateau - West	N/D	Well	35.7054903	-113.036754223	04-Sep-77	04-Sep-77				0				0				0	1.45	1.45	1.45	1				0
1204				Coconino Plateau - West	N/D	Well	35.624394252	-112.621736592	18-Oct-77	18-Oct-77				0	95.93	95.93	95.93	1				0	1.21	1.21	1.21	1				0
1205				Coconino Plateau - West	N/D	Well	35.742389614	-112.875148731	19-Oct-77	19-Oct-77				0	248.1	248.1	248.1	1				0	13.47	13.47	13.47	1				0
1206				Coconino Plateau - West	N/D	Well	35.557096928	-112.597234789	28-Oct-77	28-Oct-77				0				0				0	1.62	1.62	1.62	1				0
1207				Coconino Plateau - West	N/D	Well	35.624394256	-112.620636562	28-Oct-77	28-Oct-77				0				0				0	1.38	1.38	1.38	1				0
1217	B-25-10 26CDA	B-25-10 26CDA		Peach Springs, AZ	N/D	Well	35.51777088	-113.3168752	20-May-80	20-May-80	422.5	422.5	422.5	1				0				0				0				0
1220	B-25-11 26BAA	B-25-11 26BAA		Peach Springs, AZ	N/D	Well	35.5280478	-113.422713	24-Sep-80	24-Sep-80	481	481	481	1				0				0				0				0
1223				Peach Springs, AZ	N/D	Well	35.514693141	-113.319764217	08-Jan-78	08-Jan-78				0	107	107	107	1				0	7.42	7.42	7.42	1				0
1230	C-43-14 31BBB1	C-43-14 31BBB1		Virgin River Valley	N/D	Well	37.0099826	-113.4752298	13-Sep-79	07-Aug-96	2047.5	3150	2541.5714285714	14				0				0				0				0

Note:
1) Concentrations of As, Lb, and U, are generally from filtered samples; however some analyses are from unfiltered samples.

Abbreviations:

BA = Bright Angel
Cen = Central
E = East
GCNP = Grand Canyon National Park
gpm = gallons per minute
GRCA = Grand Canyon National Park
ID = Identifier
L = Lower
mg/L = milligrams per liter
µg/L = micrograms per liter
Mts = Mountains
N = North
N/A = Not applicable
N/D = Not determined
NF = National Forest
Q = Flow Rate
RM = River Mile
Sh = Shale
TDS = Total Dissolved Solids
USGS = U.S. Geological Survey
W = West

Appendix H

DETERMINING SOURCE OF DISSOLVED URANIUM USING ISOTOPES

The isotopic composition of uranium can be used to evaluate whether uranium in surface water and groundwater samples is derived from natural dissolution of uranium-bearing rock units or from anthropogenic activities at uranium mines (Ketterer et al. 2000; Zielinski et al. 1997). Uranium isotopic compositions from a number of studies conducted in the proposed withdrawal area, in Grand Canyon National Park, and along the Colorado River main stem were compiled in Table H-1. Recent technical advances have allowed for the precise measurement of uranium 234 (^{234}U) and uranium 238 (^{238}U) in groundwater and the ability to trace uranium inputs into river systems by comparing the abundance of ^{234}U with that of ^{238}U (Luo et al. 2000; Reynolds et al. 2003).

Natural uranium consists of three isotopes, ^{238}U, ^{235}U, and ^{234}U, with relative abundances of approximately 99.2743%, 0.7200%, and 0.0057%, respectively. Unlike the $^{235}U/^{238}U$ ratio, which exhibits an extremely small range of variation in nature, $^{234}U/^{238}U$ can vary widely in natural waters as a result of processes related to the radioactive decay of daughter ^{234}U from parent ^{238}U. These processes result in the preferential mobility of ^{234}U relative to ^{238}U during interactions between water and solid phases (Faure and Mensing 2004). Uranium in undisturbed rocks and minerals older than approximately 1 million years reaches a state of radioactive equilibrium in which the rate of decay of the short-lived ^{234}U is limited by the rate of decay of the long-lived ^{238}U parent. As a result, the $^{234}U/^{238}U$ activity ratio (AR) is expected to equal unity (defined as secular equilibrium or a value of 1 [Liebe 2003]).

Because variations in the $^{234}U/^{238}U$ activity ratio measured in some environments are very small, isotope ratios can be expressed in delta notation, $\delta^{234}U$, as follows:

$$\delta^{234}U = (^{234}U/^{238}U\ AR_{unknown} - 1) \times 1{,}000$$

Delta notation represents a per mil (‰) deviation from a known isotopic reference material, in this case, uranium in secular equilibrium. Materials in secular equilibrium will have $\delta^{234}U$ values equal to zero, whereas materials enriched in ^{234}U will have $\delta^{234}U$ values greater than zero. The presence of high levels of uranium sourced from mines will produce waters with $\delta^{234}U$ close to secular equilibrium ($\delta^{234}U \approx 0$), whereas the $\delta^{234}U$ values associated with ambient groundwater would typically be much greater than zero.

Bulk dissolution of the solid phase in a chemically aggressive environment (e.g., leachate from fresh mill tailings) results in the release of uranium that has an isotopic composition similar to that of the uranium-enriched rock (i.e., a $\delta^{234}U \approx 0$). If $\delta^{234}U$ values close to zero are detected, the concentration of dissolved uranium is expected to be high because any significant dilution from other sources of water would raise the $\delta^{234}U$ value and lower the uranium concentration. In contrast to these conditions, water-rock interaction under less chemically aggressive conditions in natural geomedia (e.g., ambient groundwater) allows preferential incorporation of ^{234}U, resulting in $\delta^{234}U$ values significantly greater than zero. Aquifers containing relatively limited amounts of water and exhibiting long residence times or flow paths will typically have lower $\delta^{234}U$ values than aquifers containing abundant water and exhibiting short residence times («1 million years) because the ^{234}U activity of the water decreases over time from isotopic decay. In this context, the R-aquifer in the Grand Canyon region contains water representative of short residence times ($\delta^{234}U \gg 0$): the oldest water age reported for the area, about 22,600 years, was obtained from a well near Williams, Arizona (Bills et al. 2007). Therefore, uncontaminated water from the R-aquifer should have high $\delta^{234}U$ values ($\gg 0$).

There are seven sources of the uranium isotopic data given in Table H-1: 1) Woodward-Clyde Consultants (1985), 2) Montgomery and Associates (Montgomery) (1993a, 1993b), 3) Fitzgerald (1996), 4) Liebe (2003), 5) Bills et al. (2010), 6) Sanchez et al. (2010), and 7) USGS National Water Information System (2010). All data were converted to $\delta^{234}U$ values for comparison using the equation given above. Review of $\delta^{234}U$ values in Table H-1 indicates that four data points from Horn Creek (Fitzgerald 1996; Liebe 2003) fall below secular equilibrium ($\delta^{234}U = 0$). In rare cases this condition can occur naturally, although it is also likely the result of analytical discrepancies and larger errors from older, less precise analytical techniques. Nevertheless, these data are consistent with leaching from a nearby uranium-rich source, in this case the Orphan Lode Mine. In order to better graphically represent the data, the negative $\delta^{234}U$ values have been set to zero; the original data are shown in Table H-1.

Table H-1. Dissolved Uranium and $\delta^{234}U$ Values for Selected Water Samples

Data Source and Site Description or Name	Sample Date	Dissolved Uranium (µg/L)	^{234}U (pCi/L)	^{238}U (pCi/L)	$^{234}U/^{238}U$ (dimension-less)	$\delta^{234}U$ (dimension-less)	Comment
Montgomery (1993b)							
Western Grand Canyon							
Havasu Spring	5/16/1985	10	3.1	1.6	1.94	938	TMA / ASU data used
	12/18/1985	4	3	1.2	2.50	1,500	TMA / ASU data used
	6/3/1986	4	3.5	1.2	2.92	1,917	TMA / ASU data used
	12/8/1986	4	4.4	2.4	1.83	833	TMA / ASU data used
	5/28/1987	4	4.28	1.45	2.95	1,952	TMA / ASU data used
	12/1/1987	4	3.83	1.55	2.47	1,471	TMA / ASU data used
South Rim, Grand Canyon National Park							
Indian Garden Spring	5/17/1985	2	3.1	0.8	3.88	2,875	TMA / ASU data used
	12/18/1985	6	2.2	0.52	4.23	3,231	TMA / ASU data used
	6/3/1986	3	2.1	0.51	4.12	3,118	TMA / ASU data used
	12/8/1986	3	4.4	1.9	2.32	1,316	TMA / ASU data used
	5/27/1987	4	2.55	0.73	3.49	2,493	TMA / ASU data used
	12/1/1987	2	2.59	0.81	3.20	2,198	TMA / ASU data used; dissolved ^{238}U calculated
Little Colorado River Below Cameron, Arizona							
Blue Spring	5/16/1985	7	4.4	1.8	2.44	1,444	TMA / ASU data used
	12/18/1985	4	4.2	1.3	3.23	2,231	TMA / ASU data used
	6/30/1986	6	3.2	1.7	1.88	882	TMA / ASU data used
	12/8/1986	6	4.2	1.4	3.00	2,000	TMA / ASU data used
	5/28/1987	4	6.09	2.78	2.19	1,191	TMA / ASU data used
	12/1/1987	6	4.44	1.75	2.54	1,537	TMA / ASU data used
Montgomery (1993a)							
Kaibab National Forest							
Canyon Mine Supply Well	12/18/1986	6.0	3.3	1.6	2.06	1,063	TMA / ASU data used
	9/10/1987	5.0	9.03	4.34	2.08	1,081	TMA / ASU data used
	12/1/1987	16.0	11.1	5.53	2.01	1,007	TMA / ASU data used

Table H-1. Dissolved Uranium and $\delta^{234}U$ Values for Selected Water Samples (Continued)

Data Source and Site Description or Name	Sample Date	Dissolved Uranium (µg/L)	^{234}U (pCi/L)	^{238}U (pCi/L)	$^{234}U/^{238}U$ (dimension-less)	$\delta^{234}U$ (dimension-less)	Comment
Fitzgerald (1996)							
South Rim, Grand Canyon National Park							
Dripping Spring	3/17/1995	1.3	1.65	0.47	3.51	2,511	
Santa Maria Spring	3/17/1995	6.2	4.30	2.21	1.95	946	
Hawaii Spring	3/18/1995	2.6	2.68	0.94	2.85	1,851	
Hermit Source Spring	3/18/1995	2.8	2.89	1.01	2.86	1,861	
Monument Spring	3/18/1995	9.0	6.71	3.24	2.07	1,071	
Cedar Spring	3/18/1995	15.6	10.59	5.57	1.90	901	
Salt Creek	3/19/1995	14.6	8.03	5.23	1.54	535	
Horn Creek	4/30/1994	24.7	8.22	8.76	0.94	0	$\delta^{234}U$ = −61.64; zero plotted
	3/19/1995	92.7	27.82	33.21	0.84	0	$\delta^{234}U$ = −162.30; zero plotted
	6/5/1995	27.6	9.48	9.9	0.96	0	$\delta^{234}U$ = −42.42; zero plotted
Two Springs Creek	4/30/1994	1.8	2.26	0.643	3.51	2,515	
	6/5/1995	1.5	2.16	0.59	3.66	2,661	
Pipe Creek	4/29/1994	2.0	2.04	0.723	2.82	1,822	
	6/4/1995	2.4	2.33	0.85	2.74	1,741	
Burro Spring	4/29/1994	2.5	2.23	0.861	2.59	1,590	
Cremation Creek	6/4/1995	7.6	5.35	2.72	1.97	967	
Sam Magee Spring	6/3/1995	3.8	2.20	1.35	1.63	630	
Lonetree Spring	6/3/1995	4.8	2.71	1.71	1.58	585	
Boulder Creek	6/3/1995	6.9	4.84	2.46	1.97	967	
Grapevine Spring	5/13/1995	1.2	1.54	0.42	3.67	2,667	
Grapevine East Spring	5/13/1995	2.8	1.68	1	1.68	680	
Grapevine Hell Spring	5/13/1995	7.0	4.94	2.5	1.98	976	
Cottonwood Spring	5/12/1995	1.1	1.47	0.41	3.59	2,585	
Cottonwood West Spring	5/13/1995	4.5	3.53	1.6	2.21	1,206	
Page Spring	5/12/1995	3.9	2.24	1.41	1.59	589	
	9/9/1995	3.7	2.09	1.31	1.60	595	
North Rim, Grand Canyon National Park							
Indian Garden Pump Station	4/30/1994	0.2	0.36	0.074	4.81	3,811	
Bright Angel Creek	4/30/1994	0.1	0.82	0.154	5.32	4,318	

Table H-1. Dissolved Uranium and $\delta^{234}U$ Values for Selected Water Samples (Continued)

Data Source and Site Description or Name	Sample Date	Dissolved Uranium (µg/L)	^{234}U (pCi/L)	^{238}U (pCi/L)	$^{234}U/^{238}U$ (dimension-less)	$\delta^{234}U$ (dimension-less)	Comment
Liebe (2003)							
South Rim, Grand Canyon National Park							
Indian Garden Spring Upstream (I.G. Up)	6/4/2002	3.1	–	–	3.87	2,870	
	6/24/2002	2.9	–	–	3.82	2,820	
	7/15/2002	2.3	–	–	3.80	2,800	
	7/29/2002	2.8	–	–	3.85	2,850	dissolved ^{238}U estimated
Indian Garden Spring Downstream (I.G. Down)	6/4/2002	2.6	–	–	3.83	2,830	
	6/24/2002	2.6	–	–	3.87	2,870	
	7/15/2002	2.4	–	–	3.81	2,810	
	7/29/2002	4.7	–	–	3.76	2,760	
Indian Garden Creek Confluence (I.G. CC)	7/15/2002	1.6	–	–	3.55	2,550	
	7/29/2002	1.4	–	–	3.64	2,640	
Indian Garden - Pipe Creek Mixing Confluence (M.C.)	7/15/2002	1.9	–	–	3.59	2,590	
	7/29/2002	2.4	–	–	3.17	2,170	
Horn Creek Upstream – spring source (Horn Up)	6/4/2002	333	–	–	1.1	100	
	6/24/2002	334	–	–	1.11	110	
	7/15/2002	400	–	–	1.1	100	
	7/29/2002	312	–	–	1.11	110	
Horn Creek Downstream (Horn Down)	6/4/2002	295	–	–	1.11	110	
	6/24/2002	303	–	–	1.1	100	
	7/15/2002	322	–	–	1.11	110	
Horn Creek Alluvium (H.E.A.)	7/29/2002	6	–	–	1.26	260	
Horn Creek West – spring source (Horn West)	7/15/2002	202	–	–	1.01	10	
	7/29/2002	135	–	–	0.99	0	$\delta^{234}U = -10$; zero plotted
Pipe Spring Upstream (Pipe Up)	6/4/2002	3.3	–	–	2.75	1,750	
	6/24/2002	3.1	–	–	2.77	1,770	
	7/15/2002	3.2	–	–	2.75	1,750	
	7/29/2002	2.8	–	–	2.76	1,760	
Pipe Spring Downstream (Pipe Down)	6/4/2002	3.6	–	–	2.72	1,720	
	6/24/2002	3	–	–	2.69	1,690	
	7/29/2002	3.4	–	–	2.71	1,710	
Pipe Creek (Pipe CC)	7/15/2002		–	–	–		
	7/29/2002	23	–	–	1.63	630	

Table H-1. Dissolved Uranium and $\delta^{234}U$ Values for Selected Water Samples (Continued)

Data Source and Site Description or Name	Sample Date	Dissolved Uranium (µg/L)	^{234}U (pCi/L)	^{238}U (pCi/L)	$^{234}U/^{238}U$ (dimension-less)	$\delta^{234}U$ (dimension-less)	Comment
Liebe (2003), continued							
Burro Spring Upstream (Burro Up)	6/4/2002	4.1	–	–	2.33	1,330	
	6/24/2002	3.5	–	–	2.35	1,350	
	7/15/2002	2.7	–	–	2.38	1,380	
	7/29/2002	3.6	–	–	2.36	1,360	
South Rim, Grand Canyon National Park							
Burro Spring Downstream (Burro Down)	6/4/2002	4.4	–	–	2.34	1,340	
	6/24/2002	4.3	–	–	2.36	1,360	
	7/29/2002	4.4	–	–	2.34	1,340	dissolved ^{238}U estimated
Unnamed Crystalline Core Spring (UCC)	7/29/2002	1.8	–	–	3.33	2,330	
Bills et al. (2010)							
Marble Canyon							
Buck Farm Springs	8/23/2009	2.82	–	–	1.837	837	
Fence Spring	8/20/2009	1.48	–	–	2.623	1,623	
Hanging Spring	8/22/2009	0.62	–	–	4.045	3,045	
Hole-in-the-Wall Spring	8/22/2009	0.6	–	–	4.124	3,124	
Unnamed Spring	8/21/2009	0.6	–	–	4.071	3,071	
House Rock Valley							
South Canyon Spring	8/26/2009	0.82	–	–	3.365	2,365	
Rider Spring	8/25/2009	4.64	–	–	2.625	1,625	
Kanab Plateau – Eastern Margin							
Clear Water Spring	8/28/2009	1.11	–	–	1.523	523	
Upper Jumpup Spring	8/27/2009	3.94	–	–	4.671	3,671	
Lower Jumpup Spring	8/28/2009	7.6	–	–	2.634	1,634	
Mountain Sheep Spring	9/1/2009	8.37	–	–	2.851	1,851	
Schmutz Spring	8/25/2009	4.59	–	–	1.883	883	
Burnt Canyon Well	9/16/2009	3.02	–	–	2.674	1,674	
Tom Land Well	9/14/2009	20.6	–	–	1.749	749	
Kanab Plateau							
Hotel Spring	8/25/2009	2.7	–	–	1.935	935	
Kanab Spring	8/26/2009	4.83	–	–	1.966	966	
Shower Bath Spring	8/26/2009	4.74	–	–	1.893	893	
Side Canyon Spring	8/26/2009	7.44	–	–	1.856	856	
Pineut Well	9/15/2009	2.14	–	–	2.285	1,285	
Slide Spring	8/27/2009	2.83	–	–	5.626	4,626	
Rock Spring	9/2/2009	12.7	–	–	2.459	1,459	
Willow Spring	8/26/2009	19.5	–	–	1.658	658	
Kaibab National Forest							
Canyon Mine Well	9/18/2009	14.4	–	–	2.017	1,017	

Table H-1. Dissolved Uranium and $\delta^{234}U$ Values for Selected Water Samples (Continued)

Data Source and Site Description or Name	Sample Date	Dissolved Uranium (µg/L)	^{234}U (pCi/L)	^{238}U (pCi/L)	$^{234}U/^{238}U$ (dimension-less)	$\delta^{234}U$ (dimension-less)	Comment
Woodward-Clyde Consultants (1985)							
Marble Canyon							
Spring 1: River Mile 25.3 East	9/19/1982	1.68	1.4	0.57	2.456	1,456	dissolved ^{238}U estimated
Spring 2: River Mile 30.5 East	9/19/1982	1.74	1.6	0.59	2.712	1,712	dissolved ^{238}U estimated
Spring 3: River Mile 30.6 East	9/19/1982	1.51	1.6	0.51	3.137	2,137	dissolved ^{238}U estimated
Spring 4: River Mile 30.8 West	9/19/1982	1.62	1.23	0.55	2.236	1,236	dissolved ^{238}U estimated
Spring 5: River Mile 30.7 West	9/19/1982	1.77	1.48	0.6	2.467	1,467	dissolved ^{238}U estimated
Spring 6: River Mile 30.7 East	9/19/1982	1.95	1.59	0.66	2.409	1,409	dissolved ^{238}U estimated
Spring 7: River Mile 35.0 West	9/19/1982	0.97	0.91	0.33	2.758	1,758	dissolved ^{238}U estimated
Spring 9: River Mile 31.2 West	9/19/1982	1.30	0.86	0.44	1.955	955	dissolved ^{238}U estimated
USGS (2010b)							
Kaibab National Forest							
355308112054101 (Canyon Mine Well)	5/20/2003	13.31	9.2	4.51	2.040	1,040	dissolved ^{238}U estimated
Coconino Plateau							
353930112075001 (Valle Well; A-26-02 01CDD)	4/13/2004	14.76	8.4	5	1.680	680	dissolved ^{238}U estimated
Havasupai Reservation							
361303112411200 (Havasu Spring; B-33-04 26)	8/23/1994	4	2.9	1.1	2.636	1,636	
361524112420400 (Havasu Spring below Supai; B-33-04 11)	8/24/1994	4	3.6	1.2	3.000	2,000	
361352112413201 (Supai Well; B-33-04 22)	8/23/1994	3.00	3.7	1.4	2.643	1,643	
Western Grand Canyon							
9404200 (Colorado River above Diamond Creek)	3/13/2001	3.45	2	1.1	1.818	818	
	8/28/2001	3.8	2.1	1.2	1.750	750	
	8/14/2002	3.71	2.2	1.2	1.833	833	
	11/23/2004	4.76	2.45	1.44	1.701	701	
Sanchez et al. (2010)							
Colorado							
Colorado River at Grand Lake	8/4/2007	0.04	–	–	1.288	288	
	7/20/2008	0.15	–	–	1.154	154	
	8/6/2009	0.23	–	–	1.498	498	
Colorado River at State Bridge	8/6/2009	0.6	–	–	1.521	521	

Table H-1. Dissolved Uranium and $\delta^{234}U$ Values for Selected Water Samples (Continued)

Data Source and Site Description or Name	Sample Date	Dissolved Uranium (µg/L)	^{234}U (pCi/L)	^{238}U (pCi/L)	$^{234}U/^{238}U$ (dimension-less)	$\delta^{234}U$ (dimension-less)	Comment
Sanchez et al. (2010), continued							
Colorado							
Colorado River at De Bisque	8/3/2007	1.59	–	–	1.6	600	
Colorado River at Fruita	7/18/2008	2.78	–	–	1.636	636	
	8/6/2009	2.97	–	–	1.655	655	
Utah							
Colorado River above Moab (Moab Up)	8/2/2007	5.28	–	–	1.591	591	
	8/8/2009	2.86	–	–	1.721	721	
Colorado River below Moab (Moab Down)	8/2/2007	6.09	–	–	1.551	551	
	7/17/2008	2.69	–	–	1.67	670	
	8/8/2009	2.96	–	–	1.722	722	
Arizona, upstream from Grand Canyon							
Colorado River at Lees Ferry	7/31/2007	3.59	–	–	1.549	549	
	7/15/2008	3.22	–	–	1.523	523	
	7/4/2009	1.43	–	–	1.68	680	
Western Grand Canyon							
Colorado River at Diamond Creek	6/29/2008	3.12	–	–	1.725	725	
	6/20/2009	2.32	–	–	1.861	861	
Arizona, Lower Colorado River							
Colorado River at Willow Beach	7/29/2007	4.51	–	–	1.769	769	
	6/29/2008	4.24	–	–	1.7	700	
	6/19/2009	2.38	–	–	1.704	704	

Notes:
µg/L = micrograms per liter
TMA = Thermo Analytical, Inc., Richmond, California
pCi/L = picoCuries per liter
ASU = Arizona State University
USGS = U.S. Geological Survey
$^{234}U/^{238}U$ = ratio of isotope 234 to 238
– = not reported
$\delta^{234}U$ = delta calculated using $(^{234}U/^{238}U - 1) \times 1{,}000$

All sample results are plotted on Figure H-1, and a subset of data with $\delta^{234}U$ values less than 1,000 is shown in Figure H-2. The large variations in $\delta^{234}U$ are readily apparent, despite the significantly higher analytical errors associated with the older data sets. Most of these data have $\delta^{234}U$ values greater than 500 and dissolved uranium concentrations of less than 20 µg/L. These data are indicative of natural weathering processes because the $\delta^{234}U$ of these samples is much greater than zero and the concentration of dissolved uranium is not elevated substantially above ambient levels (about 7 µg/L). The only results that clearly indicate anthropogenic effects are those for samples obtained from Horn Creek springs; these results have both high concentrations of dissolved uranium and low $\delta^{234}U$ values that are near or below secular equilibrium. These elevated uranium concentrations, combined with low $\delta^{234}U$ values, are associated with data reported by Fitzgerald (1996) and Liebe (2003) and are most likely indicative of surface water and/or perched groundwater interacting with the unreclaimed mine workings of the Orphan Lode Mine, which is located about 0.5 mile southwest of the springs sampled by Liebe (2003). This impacted water appears to move from the mine workings downward (about 500 vertical feet) via fractures in the Supai Group and into the Redwall and Muav limestones, where it experiences minimal dilution or attenuation while traveling the short distance to Horn Creek. The hypothesis that Horn Creek is influenced by uranium derived from mining is also supported by the higher sulfate content of these waters, presumably as a result of oxidation of associated sulfide ores, compared with other study sites (Liebe 2003).

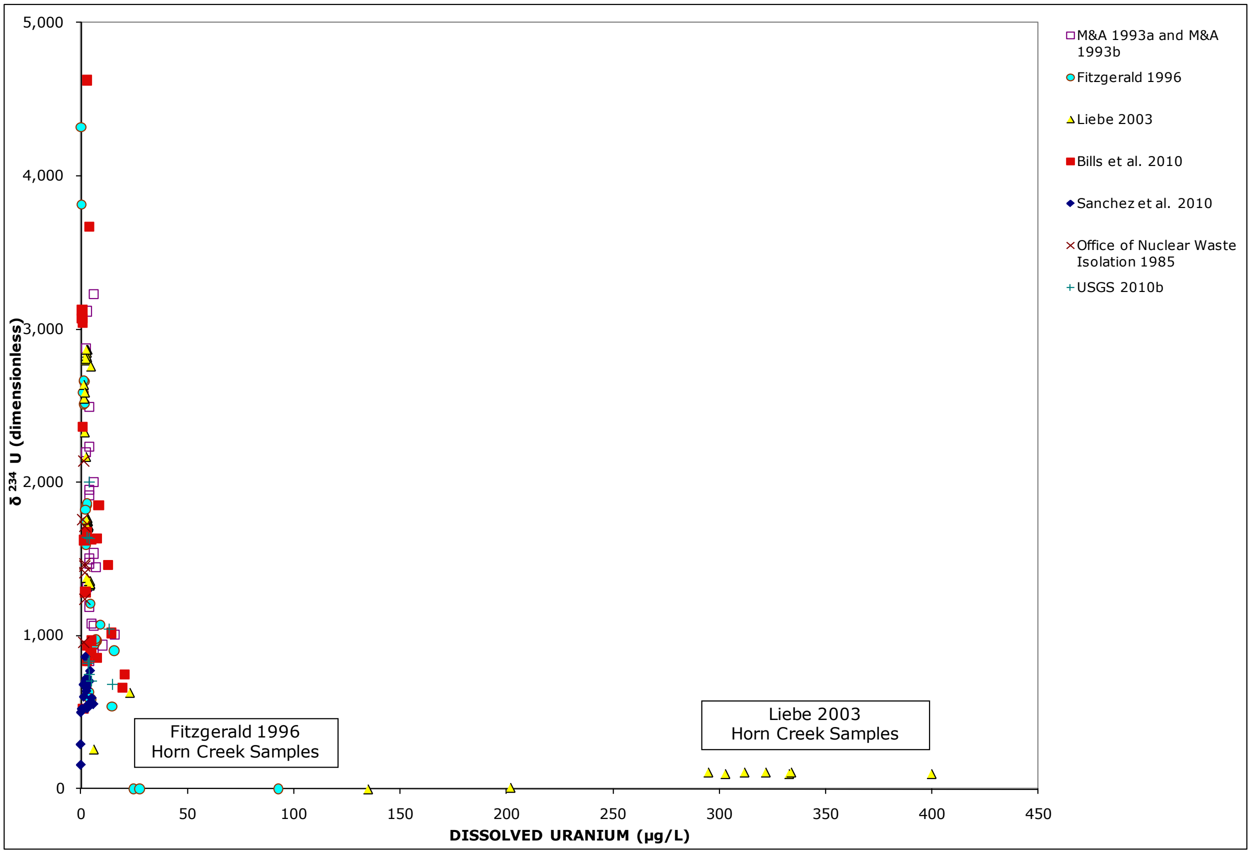

Figure H-1. $\delta^{234}U$ for selected water samples: graph of dissolved uranium versus $\delta^{234}U$ from 0 to 5,000.

Natural erosion of the exposed Orphan Lode breccia pipe in the tributary canyon of the mine or of waste materials dumped into the canyon would not likely result in a $^{234}U/^{238}U$ activity ratio near 1 in the water sampled by Liebe (2003), which together with the elevated uranium concentrations indicates an anthropogenic source. It should be emphasized that Liebe (2003) sampled the “Horn up” location on four occasions in June and July 2002, one of the worst recent drought years, when discharge was likely groundwater baseflow unaffected by surface water runoff, and obtained comparable results ranging from 312 to 400 µg/L. Further, Liebe (2003) obtained two water samples directly from another spring at the Redwall-Muav limestone contact (“Horn west”) in the next tributary canyon west of the tributary canyon below the mine. These two canyons, which are both tributary to Horn Creek, are separated by a surface water divide and a large outcrop of the Redwall Limestone (Liebe 2003). The uranium concentrations detected in the two “Horn west” samples were 135 and 202 µg/L. The $^{234}U/^{238}U$ activity ratio for both of these sampling locations is near 1, which together with the elevated uranium concentrations indicates anthropogenic sources. Both the "Horn up" and "Horn west" samples were collected at the spring source at the Redwall-Muav contact, as reported by Liebe (2003).

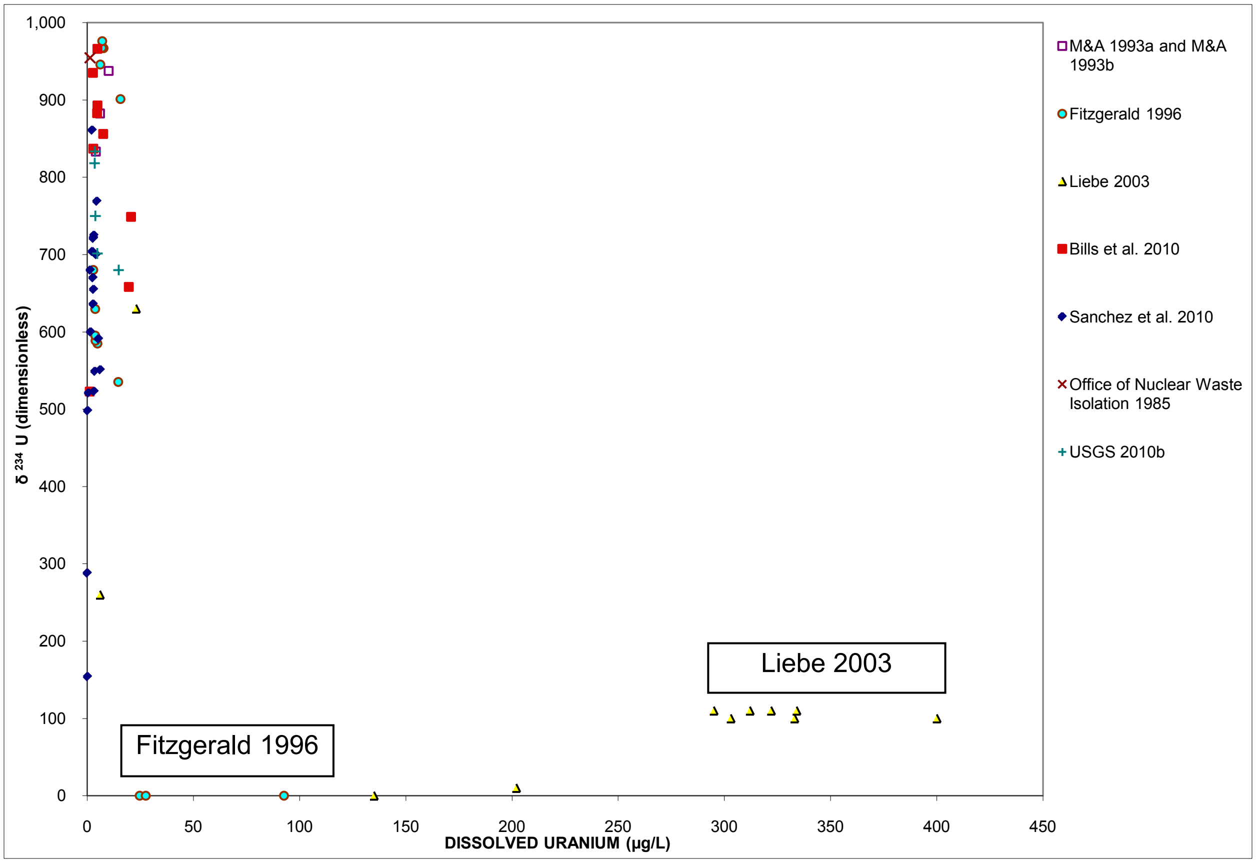

Figure H-2. $\delta^{234}U$ for selected water samples: graph of dissolved uranium versus $\delta^{234}U$ from 0 to 1,000.

The Horn Creek drainage area includes the Orphan Lode Mine, which was in production from 1956 to 1969 and is not part of current mining or exploration activity (U.S. Energy Information Administration 2005). The Orphan Lode Mine is currently a federal Superfund site, and Grand Canyon National Park has posted signs on Horn Creek warning the public not to drink the surface water because of potentially hazardous levels of radioisotopes. Monitoring for uranium isotopes alone, or combined with monitoring for uranium, strontium, and lead isotopes, provides an appropriate basis for distinguishing anthropogenic from natural weathering effects, as reflected in isotopic data for the Orphan Lode Mine and other breccia pipe uranium deposits (Gornitz and Kerr 1970; Ludwig and Simmons 1992).

In many cases, isotope mixing plots (e.g., $\delta^{234}U$ versus reciprocal U concentrations) can be used to indicate the source(s) of uranium contamination and the potential mixing relations between contaminated groundwater (high uranium concentrations and low $\delta^{234}U$ values) and ambient groundwater (low uranium concentrations and high $\delta^{234}U$ values), if the data collected are from the same flow system and are available at varying distances from high-impact areas. However, given the varied analytical methods and wide temporal and spatial differences in the current data set, such analyses would be highly speculative and are not appropriate for the EIS.

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Appendix I

CULTURE HISTORY OF THE PROPOSED WITHDRAWAL AREA

I.1 PREHISTORIC AND HISTORIC CULTURAL CHRONOLOGY

Following Willey and Phillips (1958), archaeologists generally divide the cultural history of the American Southwest (including the proposed withdrawal area) into five major periods: Paleoindian (9500–6500 B.C.), Archaic (6500 B.C.–A.D. 500 in the Grand Canyon region), Formative (A.D. 500–1300 at the Grand Canyon), Protohistoric (A.D. 1300–1540 at the Grand Canyon), and Historic (A.D. 1540–present at the Grand Canyon). The region from the Grand Canyon (or Canyon) south to the Mogollon Rim and Bill Williams River and from the San Francisco Peaks west to the Colorado River was occupied during all these periods, as discussed in numerous archaeological overviews, most importantly those of Stone (1987), Altschul and Fairley (1989), Ahlstrom et al. (1993), Burchett et al. (1994), Bair and Stoker (1994), Fairley et al. (1994), and Fairley (2004). Figure I-1 illustrates the general chronological sequence and cultural-historical units in the region.

The above-cited overviews also discuss the important research themes and questions pertaining to the Grand Canyon and surrounding region. The following overview of the culture history of this region summarizes and updates the historic contexts of the region and current research questions.

Although early occupants of the proposed withdrawal area were hunter gatherers, many groups, such as Ancestral Puebloan groups, Paiute, Cohonina, and others, practiced various types of farming and inhabited settlements on a seasonal or longer-term basis. Many factors may have affected changes in the occupation and use of this area over thousands of years, including environmental changes, population growth, migrations, conflicts, shifts in trade networks, and the adoption of farming. The following overview of the culture history of the proposed withdrawal area demonstrates its long and varied use by many different peoples.

I.1 PALEOINDIAN

The Paleoindian period was a time when peoples of the Southwest subsisted by hunting now-extinct large mammals using distinctive lanceolate projectile points (Fairley 1989a:86). During the Clovis period (9500–8800 B.C.), they hunted primarily mammoths, using fluted Clovis points. During the Folsom period (ca. 8800 B.C.), long-horned bison were hunted using fluted Folsom projectile points. During the Late Paleoindian period (ca. 7500–6500 B.C.), they hunted primarily modern bison using a number of unfluted, lanceolate projectile points.

Simonis (2001) indicates that “several mammoth sites have been found along the Colorado River,” which suggests that the principal game animal for the Clovis people was present in the region. Two Clovis point bases, two “Clovis-Folsom” point bases, and one Folsom projectile point found in the portion of northwestern Arizona from the Grand Canyon to the Mogollon Rim and from the San Francisco Peaks to the Grand Wash Cliffs provides evidence that Paleoindians used the region. Moreover, Paleoindian projectile points made from Mount Floyd and Government Mountain obsidians and rhyolites found elsewhere in the northern Southwest demonstrate that Paleoindians procured volcanic stone resources in the region and carried or traded these materials throughout the region.

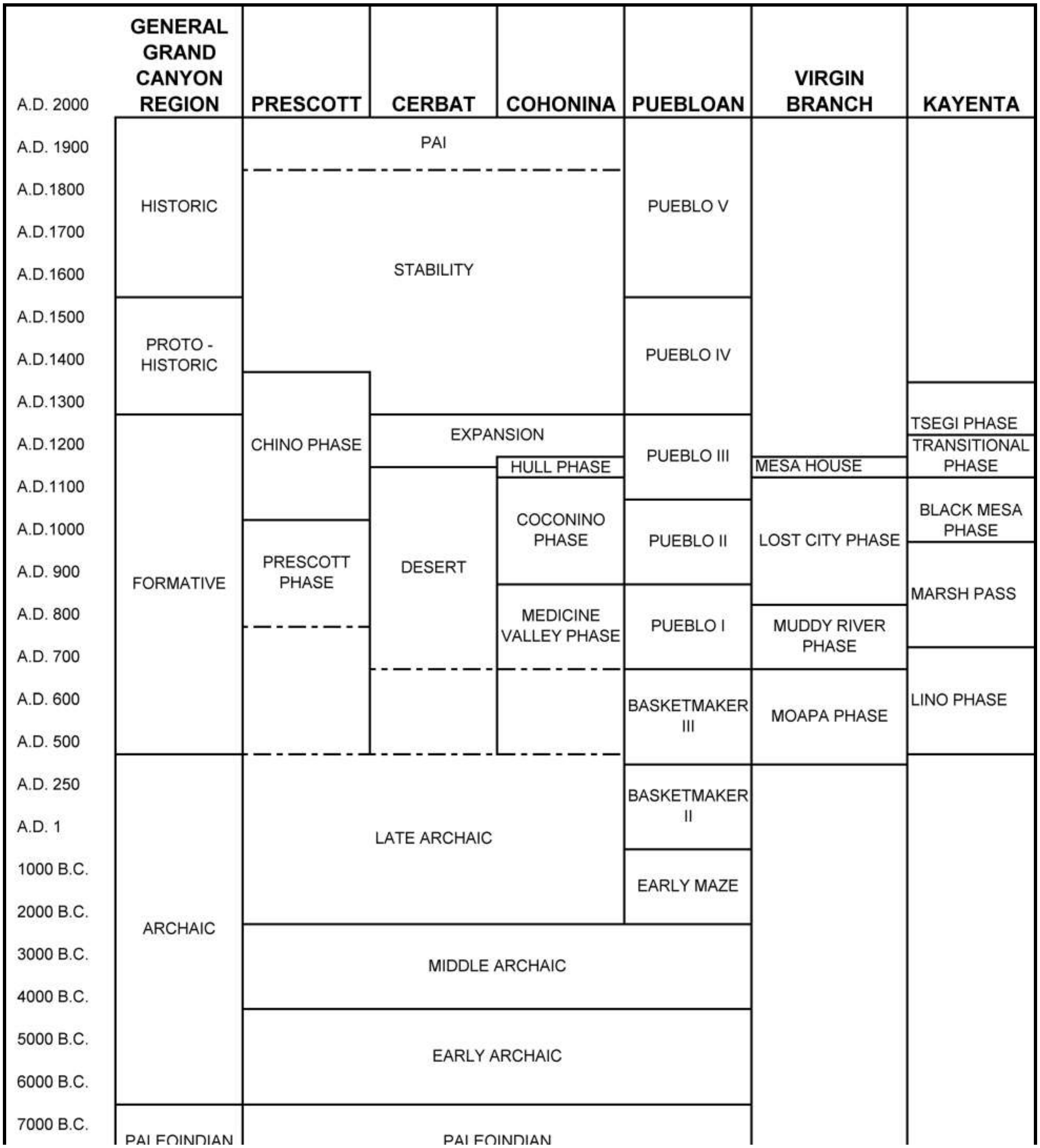

Figure I-1. Chronological sequence of cultural-historic units.

Two fluted projectile points (a base and a reworked point) classified as "Clovis-Folsom" and made of Presley Wash obsidian were found on a Formative site south of Ash Fork (Huckell 1982). Two Clovis projectile point bases from the Coconino Plateau are in Kaibab National Forest collections (Lyndon 2005). One of these was made of Government Mountain obsidian, the other, Black Tank obsidian. Pilles and Geib (2000) note that a Clovis point base found in the Village of Oak Creek, a Clovis point base from Cabin Draw (near Winona, Arizona), and the extensively reworked base of a Clovis point from

Kinnikinick Ruin (a Formative pueblo site south of Winona) were made of Government Mountain obsidian.

To date, the best evidence of Paleoindian presence in the Grand Canyon is a Folsom point from above the Redwall near Nankoweap and a Clovis point made from “paleo-pink chert” found near Desert View. A Lake Mohave point (9000–6000 B.C., which some archaeologists classify as Paleoindian and others as Archaic [Fairley 1989a:88; Lyndon 2005:56–57]), was found at AZ H:4:79(ASM) in the Watson III Prescribed Fire Unit on the South Rim of the Grand Canyon. Lyndon (2005:56–57) identified one Lake Mohave point from the Coconino Plateau in the Kaibab National Forest collections that was made of Government Mountain obsidian.

Paleoindian artifacts made from obsidians and rhyolites of the Mount Floyd volcanic field indicate that Paleoindians were using the region, acquiring stone for tools, and transporting the stone across the region. The “Clovis-Folsom” point bases of Presley Wash obsidian found near Ash Fork (Pilles and Geib 2000) have been mentioned above. According to Pilles and Geib (2000), a complete Clovis point found at Wupatki National Monument (Downum 1993) was made of Presley Wash rhyolite. A parallel-flaked Late Paleoindian projectile point of Presley Wash rhyolite was found at El Malpais National Monument near Grants, New Mexico, 490 km (307 miles) east of Mount Floyd (Powers and Orcutt 2005:46). On the other hand, Pitblado (2003:Table 7.1, Figure 5-7.1) found no Mount Floyd or Flagstaff obsidians or rhyolites in the western Colorado Paleoindian points that she sourced, which suggests that the Grand Canyon may have been a barrier between Paleoindian groups north and south of the Canyon.

Although Paleoindian projectile points from the region demonstrate that people used the area from the Grand Canyon to the Mogollon Rim and from the San Francisco Peaks to the Grand Wash Cliffs, evidence for Paleoindian use of the region is extremely rare, and none of the sites have been identified in this area, let alone excavated. Hence, almost nothing is known of the Paleoindian use of the area, other than that Paleoindians were present. Any evidence of Paleoindian use of the region is thus extremely important, even when it consists solely of isolated Paleoindian projectile points. Among the places where Paleoindian sites and artifacts might be expected are terraces around dry lakes (such as Red Lake in the Hualapai Valley) and springs (such as the springs in Grapevine Canyon near Grand Canyon West Ranch).

I.2 ARCHAIC

Following the Paleoindian period, the Archaic period began ca. 6500 B.C. and lasted until ca. A.D. 500 in the Southwest region of North America. It was marked by a subsistence strategy that was based on hunting modern species of animals and gathering wild plants (Ahlstrom et al. 1993:69). The Archaic period in the Grand Canyon was first recognized when split-twig figurines were found in caves that contained the bones of an extinct mountain goat (Emslie et al. 1995). Shaman’s Gallery (AZ B:9:201, Grand Canyon), a rock art site with painted images, dates to this period (Schaafsma 1990). Archaeological surveys on both rims of the Grand Canyon continue to document an extensive Archaic presence. Sites and artifacts from the Early Archaic period are well represented. In the woodlands and forests of the Grand Canyon area, these sites have all been identified on the basis of projectile points, virtually all of which have been associated with the Archaic projectile point traditions of the Great Basin. A few Bajada points in the Pinto tradition, representing the Archaic tradition of the southeastern Colorado Plateau, have been found. The Oshara tradition includes Rio Puerco of the east, the San Juan Basin of the Four Corners area, and the Little Colorado River valley.

Most Archaic sites consist of artifact scatters ranging in number from 30 to more than 1,000 artifacts, with an average of 200 to 250 artifacts. These assemblages are dominated by flaked stone. Ground stone has been observed at only some of the sites, and, where present, it occurs in small numbers. Thermal features have been reported, but they are relatively rare at Archaic sites. Projectile point styles include

Gypsum, Elko, Elko Corner-notched, Elko Side-notched, Elko Eared, Sudden Side-notched, Northern Side-notched, Hawken Side-notched, Rocker Side-notched, Humboldt, Pinto, and Bajada. Other tools include bifaces, unifaces, knives, scrapers, a scraper plane, choppers, both retouched and utilized flakes, and utilized cores. Local Kaibab chert dominates the flaked stone assemblage, but obsidian (from Government Mountain, Presley Wash, and Partridge Creek, based on visual inspection) occurs at a minimum of 25% of Archaic sites on the South Rim of the Grand Canyon.

McNutt and Euler (1966) reported three lithic sites on Red Butte, just south of Grand Canyon Village. Tools from the sites included stemmed Pinto points, corner-notched Ventana-Amargosa points, knives, drills, punches, ovate knives, end scrapers, and other scrapers made from Kaibab chert and a range of volcanic material. See the Ethnographic section for more on this location.

Fifteen sites with evidence of Archaic use were investigated during the Transwestern Pipeline project (Burchett et al. 1994). One site contained two middens with charred Portulaca and Chenopodium seeds; bones of cottontail, dog or coyote, and small, medium-sized, and large mammals. Most of the rest of the sites were shallow artifact scatters with few if any subsurface deposits and artifact assemblages of mixed time periods. Flaked stone included cores, flakes, and tools (mostly projectile points but also bifaces, knives, scrapers, and drills). Projectile points were mostly of the Pinto style; a few side-notched points and Gypsum points were also identified. Flaked stone was mostly Kaibab chert, along with undifferentiated cherts, quartzite, rhyolites, and obsidians from Partridge Creek and Presley Wash (in the Mount Floyd volcanic field) and two pieces of obsidian from the Government Mountain source in the San Francisco Mountains volcanic field. At least three of the sites were interpreted as lithic raw material procurement sites at which Kaibab chert was collected and initial processing occurred. The lithic raw material procurement sites often contained a few tools, including obsidian tools, which suggested that lithic raw material procurement probably occurred in conjunction with other activities.

Excavations at Bighorn Cave in the Black Mountains west of Kingman (Geib and Keller 2002) provided extensive data on the Archaic subsistence practices and material culture in the region. Four periods of occupation were represented: 1) Late Archaic (1200–400 cal. B.C.); 2) terminal Archaic (200 cal. B.C.–cal. A.D. 100); 3) Formative (cal. A.D. 550–1200); and 4) Late Prehistoric–Protohistoric (cal. A.D. 1300–1700). The Late Archaic occupation of the cave was represented by one vegetation-lined pit (perhaps for curing screwbean mesquite pods), one roasting pit, and five hearths, as well as artifacts that included San Pedro points, Gypsum points, corner-notched dart points similar to Elko points, and two split-twig figurines (previously collected by looters). Oak leaves, hackberry leaves, and pinyon nuts indicated that the climate may have been somewhat cooler and wetter at this time. Flaked stone tools were indicative of a reliance on hunting.

Lyndon (2005) analyzed projectile points recovered from archaeological projects on the Coconino Plateau of the South Parcel. All periods from Paleoindian to Historic were represented. Archaic points could be classified as Great Basin types (Northern Side-notched, Sudden Side-notched, Gypsum Cave, Elko Eared [Jennings 1986]), and Oshara tradition types (Jay, Bajada, San Jose, Armijo [Irwin-Williams 1973]). Early Archaic (8000–6200 B.P.) projectile points were mostly Bajada points (n=15), although six Northern Side-notched points were present. Most of these points were made of obsidians and rhyolites from Mount Floyd and Government Mountain, but one Bajada point was made from Owl Rock chert from east of the San Francisco Peaks. Middle Archaic (6200–4600 B.P.) projectile points were mostly Pinto or San Jose points (n=33), although 10 Sudden Side-notched points were present. Most of the Middle Archaic points were made of obsidians and rhyolites from Mount Floyd and Government Mountain, but some were made of chert. Late Archaic projectile points included 34 Gypsum Cave Points, 23 Elko Eared points, nine "Chiricahua" projectile points, eight Armijo projectile points, seven San Rafael Side-notched points, and two Gatecliff Split-stemmed points. Most of the Late Archaic points were made of obsidians and rhyolites from Mount Floyd and Government Mountain, but some were made of Kaibab chert, other cherts, and chalcedony.

During Late Archaic times, maize was introduced to the Colorado Plateau. Maize has been found on Carrizo Wash in west-central New Mexico dating to as early as 2000 B.C. (Huber and Miljour 2004) and in the Chinle Valley and on Black Mesa dating to as early as 1000 B.C. (Gilpin 1994; Smiley 1994). In his analysis of projectile points from the Coconino Plateau in the collections of the Kaibab National Forest, Lyndon (2005) identified 17 side-notched points and 25 knives that he thought were characteristic of the Basketmaker II period (2400–1550 B.P.). At Bighorn Cave (Geib and Keller 2002), the terminal Archaic (200 cal. B.C.–cal. A.D. 100) was represented by one pit, one roasting pit, and one hearth, along with San Pedro points, Gypsum points, corner-notched dart points similar to Elko points, fringed split twigs, fabric made from S-twist cordage, and human coprolites (which contained agave, prickly pear fibers, screwbean mesquite pods, and goosefoot or pigweed greens); the only cultigen present was a squash seed. To date, few sites representing the transition to agriculture have been found at or near the Grand Canyon, although sites dating to the relevant time have been found along the Colorado River Corridor (Fairley 2004:82–88; Fairley et al. 1994:100). The major focus of research on the Early Agricultural period is to directly date cultigens to find out when they were first grown in the area and to collect other data on subsistence at sites dating to the Early Agricultural period to examine the role of cultigens in the overall subsistence strategy of the period.

I.3 FORMATIVE

The Formative period (from about A.D. 500–1300 at Grand Canyon) is defined as the time when peoples of North America domesticated crops, began making pottery, and transitioned to settled village life (Ahlstrom et al. 1993:72; Willey and Phillips 1958:146). Although maize appears on the southern Colorado Plateau, near Quemado, New Mexico, as early as 2000 B.C. (Huber and Miljour 2004), cultivation of domesticated plants in northwestern Arizona did not begin until about A.D. 500, at which time pottery making also began, the bow and arrow were introduced, and settled villages appeared (Ahlstrom et al. 1993:72; Bungart 1994a:101–102; Fairley 1989a:112). People originally lived in pit houses (essentially a roofed pit), but by about A.D. 900, they were constructing aboveground masonry houses. During the Formative period, three archaeological traditions developed in northwestern Arizona: Cohonina, Prescott, and Cerbat (see Figure I-1). In addition, the Ancestral Puebloan, Virgin Branch (or the Virgin Branch) tradition is found mainly north and northwest of the Grand Canyon, while the Ancestral Puebloan, Kayenta Tradition (or the Kayenta Tradition) tradition is found mainly south and east of the Grand Canyon.

Archaeological studies surrounding the Grand Canyon from the Arizona Strip to the Mogollon Rim and from the San Francisco Peaks to the Colorado River have resulted in several classifications of the Formative cultures in the area. Different classifications have resulted from different interpretations of the cultural history, centering on whether the Puebloan, Cohonina, Prescott, and Cerbat cultures were contemporaneous or not. Bone (2002) has a good discussion of the changing interpretations of the Cohonina.

Patayan, Upland Patayan, and Hakatayan refer broadly to the Formative traditions that existed in the region. Gladwin and Gladwin (1930) called these sites Yuman. Colton (1939) objected to the use of a linguistic term, Yuman, to designate archaeological material culture, proposing instead the term Patayan (Pai for "ancient ones") with three branches: Cohonina, Prescott, and Cerbat.

Euler (1958, 1963) inferred that Cerbat culture, initially (from about A.D. 700–1150) restricted to the Lower Colorado River, expanded eastward and onto the Colorado Plateau after about A.D. 1150 and ultimately became the Pai culture. Euler, however, thought that the Cohonina and Prescott cultures were not closely enough related to the Cerbat to be considered Patayan. Furthermore, he argued that the Cohonina had once (prior to about A.D. 1150) extended almost all the way to the lower Colorado River on the west and that they had been replaced by the Cerbat after about A.D. 1150. In similar fashion, Prescott culture was replaced by Cerbat culture after about 1300 or 1400.

Schwartz (1955, 1956, 1957, 1958) at one time suggested that the Cohonina were ancestral to the Havasupai. He has since adopted Euler's reconstruction (Schwartz 1989:38).

Schroeder (1979) proposed a Hakataya culture that occupied the region from the Colorado River on the north to the Gila River on the south and from the Mazatzal Mountains on the east through the Mojave Desert of California on the west, extending south into Baja California. Schroeder incorporated 11 archaeological traditions within this culture: Roosevelt, Verde, Cohonina, Prescott, Agua Fria, Gila Bend, Cerbat, Amacava, La Paz, Palo Verde, and Salton. All of these groups were highly mobile, relying on agriculture only to supplement hunting and gathering, and constructed rock-outlined jacal dwellings, made paddle- and anvil-thinned pottery, and used bedrock milling stones.

Schroeder's classification has not been widely accepted (Bone 2002:19), and most archaeologists today follow Euler's reconstruction, with modifications (see Ahlstrom et al. 1993; Fairley 2004; Fairley et al. 1994). Most archaeologists working in the Grand Canyon today accept Euler's contention that Cohonina culture once (prior to A.D. 1150) extended almost all the way from the San Francisco Peaks west to the Colorado River, that Cerbat culture replaced Cohonina culture after about A.D. 1150, moving from west to east, and that Cerbat culture replaced Prescott culture after about A.D. 1300 or 1400.

These archaeologists, however, are revising the descriptive-classificatory views of what constitutes Cohonina, Prescott, and Cerbat archaeological material cultures and the views about what it means for one archaeological material "culture" to replace another. Cartledge (1979, 1986) introduced a new way of looking at the Cohonina: in terms of communities. In a series of M.A. theses, students at Northern Arizona University have further examined the organization of communities and have begun to examine how styles of various categories of archaeological materials (flaked stone, pottery, architecture, settlement patterns) reflect cultural identity (Bone 2002; Horn-Wilson 1997; Lyndon 2005; Roberts 2001; Samples 1992).

I.3.1 Ancestral Puebloan, Virgin Branch

The Ancestral Puebloan, Virgin Branch tradition was centered on confluence of the Virgin and Colorado rivers and extended east through most of the Arizona Strip. The Puebloan cultural chronology throughout the Southwest is usually described in terms of the Pecos Classification (Kidder 1927), which divides Ancestral Puebloan cultural development into seven periods: Basketmaker II (500 B.C.–A.D. 400), Basketmaker III (A.D. 400–700), Pueblo I (A.D. 700–900), Pueblo II (A.D. 900–1100), Pueblo III (A.D. 1100–1300), Pueblo IV (A.D. 1300–1540), and Pueblo V (A.D. 1540–present). The Pecos Classification was largely developed in the Kayenta region, so the classification quite accurately reflects Kayenta culture history. The Virgin tradition developed on the edge of the Puebloan world and departs from the Pecos Classification to some degree. In the Virgin cultural chronology, for example, the Pueblo II period is usually dated from A.D. 900–1150, and the Pueblo III period is usually dated from ca. A.D. 1150–1225.

During Basketmaker II times, maize horticulture was practiced and shallow pit houses and slab-lined storage pits were constructed. Pottery had not yet been introduced to the Southwest.

During the Basketmaker III period, pit houses continued to be used, circular aboveground storage units were constructed, and plain gray ware pottery (called Mesquite Gray in the Virgin River area) and black-on-gray pottery (called Mesquite Black-on-gray in the Virgin River area) began to be produced. The bow and arrow was introduced. In most of the Pueblo world, most habitations consisted of a pit house with an arc of circular aboveground storage structures behind (north and west of) the dwelling. In the Virgin

River area, pit houses without aboveground storage structures were most prevalent (Fowler and Madsen 1986:175–179).

During the Pueblo I period, habitations in most of the Pueblo world consisted of a pit structure with an arc-shaped multi-room surface structure behind the pit structure. The pit structures were beginning to take on increasingly ceremonial functions; surface rooms were used for a variety of functions, including storage and workspace. In the Virgin River area, the most complex settlements were like Basketmaker III sites elsewhere, pit houses in front of arcs or chains of circular, slab-lined storage cists and rooms. In most of the Pueblo world, utility pottery was sometimes neck banded; black-on-white painted pottery also began to be produced. In the Virgin River area, neck banding was not as common, and the painted pottery is called Washington Black-on-gray (Fowler and Madsen 1986:175–179).

During the Pueblo II period, habitation sites in most of the Pueblo world were generally composed of a block of aboveground coursed-masonry rooms with a subterranean kiva in front. In the Virgin River area, these aboveground pueblos often consisted of arcs or chains of irregularly shaped rooms. In the heartland of the Virgin culture area, the Moapa Valley of Nevada, a large settlement known as Pueblo Grande de Nevada or the Lost City complex consisted of more than 100 individual sites (Lyneis 1996:Table 2.1), which were as large as 18 habitation rooms and 106 storage rooms arranged in chains, arcs, and circles (Lyneis 1996). Possible kivas have been reported in the Virgin culture area. In most of the Pueblo world, indented corrugated utility ware pottery and black-on-white painted pottery were produced. In the Virgin River area, the black-on-white pottery style of this period is called St. George Black-on-gray. Ceramic variability increased as the Virgin area increased, and regional variants of Virgin pottery—Moapa, Shivwits, and Shinarump wares—were developed. Moapa Gray Ware, tempered with olivine from the Mount Trumbull area, was the most distinctive ware produced by the Virgin Branch peoples during this period, and it was widely traded.

During the Pueblo III period, large, plaza-oriented pueblos began to be constructed over much of the Puebloan region. Pottery was indented corrugated, black-on-white, black-on-red, and polychrome. In the Virgin River area, the Pueblo III period was characterized primarily by the gradual end of permanent Puebloan habitation.

Permanent Puebloan habitation is not represented in the Virgin River area during the Pueblo IV period, when Puebloan populations elsewhere continued to aggregate into progressively larger pueblos in Arizona and New Mexico. During the Pueblo IV period, permanent habitation coalesced around the locations of the modern pueblos: Hopi, Zuni, Acoma, Laguna, and Rio Grande.

Although the Virgin Puebloans were adjacent to the Cohonina on the north and west prior to the spread of Cerbat culture into the area ca. A.D. 1150, the Virgin Puebloans and the Cohonina were separated by the Grand Canyon. Puebloan pottery produced by the Kayenta peoples, who lived northeast of the San Francisco Peaks, is commonly found in eastern Cohonina sites. Sherds with olivine temper were reported at Locus B of AZ G:1:10(ASM), which suggests some trade relations between the Virgin Puebloans and the Cohonina.

I.3.2 Ancestral Puebloan, Kayenta Tradition

Kayenta is the largest Ancestral Puebloan region, spanning northern Arizona, southern Utah, and southwestern Colorado. Bounded on the south by the Grand Canyon and the Little Colorado River valley, it extends up the Colorado River through Glen Canyon to the junction with the Fremont River. Some researchers call the western part of the region Virgin Kayenta, for the Virgin River in southwestern Utah and northwestern Arizona. The Kayenta region is well defined as a result of large-scale, long-term projects that have yielded high-quality information (Cordell 1997:195).

There is a wealth of data representing the Basketmaker II and Basketmaker III periods, with the unique addition of perishable wares recovered from cave sites such as White Dog Cave. Kayenta tradition follows similar development patterns found elsewhere in the Ancestral Puebloan region during these periods. The cultural markers include pit houses, Lino-style pottery, twined basketry, and one-hand ground stone. There is also little divergence from other Puebloan traditions into Pueblo I, with the continued use of pit houses, introduction of surface storage rooms of jacal or jacal-and-masonry construction, and production of Kana-a ceramics. Alkali Ridge Site 13, in southeastern Utah, is an example of a Pueblo I (ca. A.D. 750–975) period Kayenta settlement and is noted for its extraordinary size (Cordell 1997:196).

During Pueblo II (ca. A.D. 975–1150), the Kayenta Tradition population reaches its greatest geographic extent while also becoming more insular, as evidenced by the decrease in the amount of trade goods recovered from sites of this period. The adoption of smaller dispersed homesteads during this period further supports this theory. However, Dogoszhi style pottery from the Chaco Canyon region has been recovered from these sites, which suggests that while insular, the Kayenta did have outlets into the Ancestral Puebloan world (Neitzel 2007:407).

The Upper Basin Archaeological Project has greatly contributed to the understanding of the Kayenta south of the Grand Canyon during Pueblo I and II (e.g., Carter and Sullivan 2007; Sullivan 1986, 1988, 1992, 1995; Sullivan and Becher 1991; Sullivan et al. 2003). The Upper Basin is located just south of the Grand Canyon National Park (or Park) in the northeast corner of the South Parcel. Survey and excavation by the Upper Basin Archaeological Project has demonstrated that the Kayenta subsistence system consisted of a “three-tiered settlement system” (Sullivan 1995). The first tier consisted of villages occupied year-round; the second tier consisted of settlements occupied on a seasonal basis, such as field houses and one-room settlements; and the third tier consisted of sites briefly occupied during plant processing or other short-term activities (Sullivan 1995). Significantly, a one-room settlement second tier site excavated in the Upper Basin provided clear evidence of ceramic manufacturing, including an ash-filled depression with waster sherds where ceramics could have been fired (Sullivan 1986, 1988).

The Kayenta did not follow the village aggregation pattern found in other Ancestral Puebloan areas, such as Chaco Canyon and Mesa Verde, until Pueblo III (ca. A.D. 1150–1300), and maybe as late as A.D. 1250. Around A.D. 1150, there was upheaval in the Kayenta world, with the abandonment of areas such as Black Canyon and Virgin River while large pueblos were being constructed elsewhere, such as at Tsegi Canyon. These changes herald the final Kayenta occupation from A.D. 1250–1300. The Tsegi phase, as it is called, is identified by erratic settlement patterns, circular and keyhole-shaped kivas, and the production of “Kayenta style” ceramics with negative-painted designs. By A.D. 1300, it appears that the Kayenta had abandoned the landscape; however, there is evidence of cultural continuity with the middle Little Colorado drainage and other Ancestral Hopi areas (Cordell 1997:196).

I.3.3 Cohonina Tradition

Cohonina sites have been identified from the Grand Canyon on the north to the Mogollon Rim and the headwaters of the Big Chino Wash and Big Sandy River on the south, and from the Little Colorado River on the east to the Colorado River on the west. Euler (1958) found evidence of the Cohonina in the Kingman area, where it was usually present stratigraphically beneath Cerbat material and usually in association with Prescott Gray Ware (Simonis 2001).

A number of chronological sequences have been developed for the Cohonina. Colton (1939) defined three foci: Medicine Valley (A.D. 700–900), Coconino (A.D. 900–1120), and Hull (A.D. 1120–1200). Gladwin (1943) later used the term phases for Colton’s foci, a practice followed by most archaeologists today (see, for example, Schwartz [1955], who added a Hermit phase [A.D. 600–700] to the beginning of the sequence). The range of chronological sequences for the Cohonina led Cartledge (1986) to recommend that Cohonina archaeology needed no more chronological frameworks and cultural classifications, an idea seconded by Bair (1994:269). On the other hand, Brew (1946) long ago pointed out that classifications are not an end in themselves and should always derive from the research goals of the classifier.

The Cohonina made San Francisco Mountain Gray Ware (Ahlstrom et al. 1993:73–74). The paste is sedimentary clay, which is tempered with fine quartz and feldspar sand, angular to subrounded, with some mica. The relatively thin pottery is ring-built (formed by adding thick coils to a base slab), scraped, and thinned using a paddle and anvil. Pottery types are Floyd Gray (A.D. 700–900), Floyd Black-on-gray (A.D. 700–900), Deadmans Gray (A.D. 775–1200), Deadmans Fugitive Red (A.D. 850–1150), Deadmans Black-on-gray (A.D. 900–1100), Kirkland Gray (undated), and Bill Williams Gray (undated). Ceramic compositional studies to date have not been successful in identifying production localities for San Francisco Mountain Gray Ware (Mills et al. 1993; Roberts 2001).

Schroeder (1979:Figure 9) originally defined Cohonina projectile points as being long and thin with serrated edges. Horn-Wilson (1997), however, identified 12 types of projectile points on Cohonina sites and concluded that while Schroeder's "Cohonina projectile points" were one of these types, they were not the only type made and used by the Cohonina. In his analysis of projectile points recovered from archaeological projects on the Coconino Plateau of Kaibab National Forest, Lyndon (2005) classified virtually all (n=69) of the Early Ceramic period (A.D. 400–700) projectile points as Rosegate points. Late Ceramic period (A.D. 700–1300) projectile points were mostly Cohonina points (n=43, although Lyndon did not analyze all the available specimens, since Horn-Wilson had previously analyzed them). Also dating to this period were 24 un-notched triangular points, 10 Kahorsho Serrated points, three Nawthis Side-notched points, two Parowan points, one basal-and-side-notched point, and one Sitgreaves Serrated point.

Although the Cohonina practiced limited agriculture, they primarily relied on gathering wild plants and hunting. Sites on the headwaters of the Big Sandy River, excavated during the Transwestern Pipeline project (Bair and Stoker 1994), provide some of the most recent information on Cohonina subsistence practices. Pollen samples yielded pollen of pine, cheno-ams, beeweed, purslane, Umbelliferae (parsley family), cholla, and maize. Flotation samples yielded wood of juniper, pine, saltbush/greasewood, and Apache plume. Maize was the only cultigen present. Wild plants represented in the flotation samples included seeds of juniper, dropseed, clammyweed, cheno-ams (including goosefoot), purslane, sunflower, panic grass, Deschampsia, and yucca, as well as pinyon nuts. Faunal bone from the sites represented a wide range of taxa: large mammals (including medium-sized ungulates, artiodactyls, pronghorn, deer, and bighorn sheep), medium-sized mammals (gray wolf, coyote/dog, bobcat), rabbit-sized mammals (cottontail and jackrabbit), rodent-sized mammals (prairie dog, Botta's pocket gopher, pocket mouse, grasshopper mouse, kangaroo rat, woodrat), birds (including northern flicker and roadrunner), lizards, snakes, and turtles/tortoises (including snapping turtle).

Cohonina architecture included masonry pueblos and pit houses, but they did not construct kivas. Bone (2002) investigated Cohonina public architecture ("forts," plazas and long rooms, and ball courts) on the Coconino Plateau. He divided his study area into a northern area (bounded by SR 180 on the north and east, Interstate 40 on the south, and SR 64 on the west) and a southern area (south of Interstate 40 between Interstate 40 and the Mogollon Rim). More than 200 habitation sites were present in the northern area, along with seven "forts" and five plaza sites or sites with long rooms. More than 200 habitation sites were present in the southern area, along with three "forts," one site with a plaza or long room, and four ball courts.

Cartledge (1979, 1986) proposed that the Cohonina lived in communities clustered in the woodlands around the bases of the major mountains of the Coconino Plateau: Kendrick, Sitgreaves, and Bill Williams mountains. (In addition, based on McGregor's [1967] work around Mount Floyd, a community may also have surrounded this mountain as well.) Most communities apparently consisted of small, single-family residential sites clustering around the bases of these mountains (Cartledge 1979, 1986; Samples 1992; Wilcox et al. 1996). Within each cluster are several types of public architecture: "forts," sites with large plazas, sites with long rooms, and ball courts (Bone 2002).

Samples (1992) and Bone (2002) identified community organization in the Sitgreaves Mountain cluster that appears to mirror that of the Medicine Valley area and, to a lesser extent, the Red Butte and Mount Floyd area, but not the other areas. Samples (1992) analyzed 380 sites in 40 square miles (64.4 km^2) around Sitgreaves Mountain. The sites included 242 habitations, one rock art site, five check dams, and 132 artifact scatters. The habitation sites contained an estimated 649 structures, including 301 pit houses and 348 masonry structures.

In 1980 and 1981, Westec Services, Inc., conducted archaeological survey and data recovery in the Hualapai Valley (Schilz 1982). The archaeological survey of 12 sections of land (7,680 acres) and 51 miles of proposed roads, power lines, and pipelines identified 67 sites. Data recovery was conducted at 20 sites (Simonis 2001). The project indicated that the Hualapai Valley was occupied by the Cohonina and the Cerbat from ca. A.D. 900 to historic times. The people using the valley were camping on the dunes, probably seasonally, and farming and gathering on the dunes next to mudflats, manipulating water with check dams. The archaeologists did not excavate any structures, but they observed some depressions in the dunes that were probably shallow pit houses, basically wickiups. No masonry structures were present. The area would have had substantial food potential, with cultigens, grasses, dock, and other wild plants. The Hualapai Valley was probably home to a perennial stream until the late 1800s, when ranchers began drilling wells and lowering the water table.

Horn-Wilson's (1997) analysis of projectile points from different clusters of excavated sites on the Coconino Plateau indicated that settlement locations may have shifted over time. Early Cohonina (A.D. 850–1000) projectile points were found in four areas: Red Butte, Medicine Valley, Baker Ranch, and Mount Floyd. Late Cohonina (A.D. 1000–1075) points were found in four areas: Red Butte, Medicine Valley, Sitgreaves Mountain, and Red Lake. Very late Cohonina (A.D. 1075–1200) points were found in only two areas: Red Lake and Medicine Valley. Thus, only Medicine Valley was probably occupied throughout the Formative period, Red Butte was probably occupied in the early and late periods, Red Lake was probably occupied in the late and very late periods, Brown Ranch and Mount Floyd were probably occupied only in the early period, Sitgreaves Mountain was probably occupied only during the late period, and Mesa Butte yielded no projectile points dating to any of the three periods.

Investigations over a broad area have demonstrated the range of variability in the Cohonina tradition. Horn-Wilson (1997) found that archaeological excavations had occurred at almost 70 Cohonina sites. Forty-nine of these sites were within seven areas: Medicine Valley, eight sites (Colton 1946); Baker Ranch, five sites (Colton 1946; McGregor 1951; Spicer 1934); Mesa Butte, one site (Fiero et al. 1980); Red Butte, four sites (McGregor 1951; Schroeder 1997); Red Lake, 19 sites (Colton 1946; Fiero et al. 1980; McGregor 1951); Sitgreaves Mountain, three sites (Samples 1992; Wilcox et al. 1996); and Mount Floyd, six sites (McGregor 1967). In addition, Matson (1971) has investigated sites north of Kingman, Schilz (1982) conducted survey and excavation at Cohonina sites in the Hualapai Valley, Geib and Keller (2002) excavated a Cohonina component at Bighorn Cave, and Bair and Stoker (1994) excavated 15 Formative sites during the Transwestern Pipeline project: 14 at the headwaters of the Big Sandy River, west of Seligman, and one (Site 442-39) in the Chino Valley east of Seligman. The 14 sites at the headwaters of the Big Sandy River constitute a cluster not included in Horn-Wilson's study area; the latter site is in her Mount Floyd cluster.

In addition, many of these excavations were conducted prior to the development of modern methods of pollen analysis, flotation analysis, flaked stone debitage analysis, obsidian sourcing, and other analytical tools that are routinely employed today. Thus, new excavations at sites in the region supplement data from previously excavated sites by gathering types of information not previously recovered.

I.3.4 Cerbat Tradition-Yuman Groups

Evidence of the Cerbat cultural tradition (primarily Tizon Brown Ware) is found from the Colorado River on the north and west to the Verde River on the east and the Bill Williams River on the south.

The tradition dates from about A.D. 700–1850 and is considered ancestral to and including the modern Pai (U.S. Forest Service [Forest Service] 1996:180). The Cerbat were primarily mobile hunters and gatherers who practiced limited agriculture and lived in natural rock shelters or constructed temporary shelters such as wickiups. Cerbat culture is defined primarily on the basis of Tizon Brown Ware.

The Cerbat are considered to be one of the western Arizona Pai groups that made up part of the Upland Patayan culture. Patayan was term that was coined by Colton for the archaeological material culture of the people who inhabited southern California, northern Baja California, and western Arizona. Populations who inhabited the lower-elevation desert areas were part of what he called the lowland groups and included the Mojave and Quechuan, among others. Their pottery included Tizon Brown and Lower Colorado Buff wares, which were paddle and anvil pottery that was similar in some respects to most Arizona wares, with the exception of Puebloan ceramics.

One view portrays the Pai and other Yuman groups as originating in southern California and Baja California. Anthropologists theorize that these groups moved into Arizona some time after A.D. 1300, gradually spreading northward and eastward (Dobyns 1974b; Reid and Whittlesey 1997). Ceramic evidence from archaeological contexts suggests otherwise, however; this evidence shows that the groups were in place sometime ca. A.D. 1000 and perhaps long before that. Their pottery appears on sites throughout the northern Mojave and upper Sonoran Deserts in Nevada, California, and western Arizona at that time. It is not known whether they had been in the region for much longer and became visible at that point in the archaeological record as a result of the adoption of ceramic technology.

The Cerbat are generally believed to be the direct ancestors of the Upland Pai groups of the Havasupai, Hualapai, and Yavapai, although the Yavapai also claim descent from the Prescott culture, whereas the Havasupai and Hualapai also claim descent from the Cohonina (Hanson 1996; McKey 1996; Simonis 1996). The relationship between the Yavapai and the Prescott culture is a matter of debate among archaeologists. This argument is based, in part, on a gap in the archaeological record between the prehistoric cultures of the area and the Protohistoric cultures observed by the Spanish.

Research on mitochondrial DNA (mtDNA) has led researchers to conclude that Upland Yuman groups such as the Yavapai may have had their origin in Arizona–New Mexico rather than southern California (Malhi et al. 2003). Other genetic studies demonstrate a high frequency of the same Albumin Mexico gene in Upland Yuman and Pima groups (Schell and Blumberg 1977). Linguistic evidence further suggests a concordance between Upland Yuman and Piman. Far less of a link can be established between the Upland and Lowland Yuman groups. All of this evidence, combined with other lines of proof from throughout the Southwest, suggests successive early and pre-ceramic migrations of linguistically and genetically related people from northern Mexico into adjacent areas. Sometime later, the Patayan Ceramic tradition spreads, from south to north, into entire region (Rogers 1936, 1945; Seymour 1997; Stone 1991; Waters 1982).

Cerbat and Prescott peoples may have contributed to a relationship analogous to that of the various groups of Yuman-speaking peoples at the far western edge of Arizona. Each of these different Lowland groups relied on agriculture to varying extents. Where extensive areas for agriculture were available, some groups relied on agriculture, supplemented by gathering wild plants and animals. Other areas along the river were less conducive to farming, so populations there relied primarily on hunting and gathering, supplemented by farming or trade with those other agriculturally based groups (Braatz 2003; Khera and Mariella 1982; Steward 1983; Stone 1991). Upland groups often traded upland resources such as acorns and pine nuts for corn and squash with lowland people, or in some cases, reciprocal use of territories was allowed by select Upland and Lowland groups.

The best example of this is the relationship between the Tolkepayas (westernmost Yavapai) and the Quechans (Lowland Yumans). The Tolkepayas periodically settled in Quechan territory along the Colorado River where they would seasonally plant crops. The Quechans would, on occasion, venture into Tolkepaya territory in the mountains where they would hunt game and collect raw materials for grinding stones (Braatz 2003:33–34).

Analogous to the above relationships, the Cerbat were known to occupy marginal areas where agriculture was risky even in the best of times, while the Prescott peoples lived in zones where agriculture normally could be practiced. When climatic conditions were good for agriculture, some Cerbats would have moved in with their Prescott relatives for trade and intermarriage. When climatic condition were not compatible with high agricultural productivity, the more sedentary Prescott peoples probably increased their reliance on wild resources temporarily abandoning fields to join the Cerbats. Droughts throughout the Southwest in the thirteenth and fourteenth century might have severely limited the agricultural potential of the Prescott area. This created a situation where some Prescott culture farmers had to abandon agriculture and integrate into the Cerbat bands. Others may have joined Puebloan groups in the Little Colorado River valley.

Cerbat sites have been identified from the Grand Canyon on the north to the Bill Williams River and northern Phoenix Basin on the south and from the Verde River on the east to the Colorado River on the west. Euler (1963) divided Cerbat cultural history into three periods: 1) the Desert period (A.D. 700–1150), when the Cerbat lived in lowland areas west of the Grand Wash Cliffs; 2) the Expansion period (A.D. 1150–1300), when the Cerbat expanded eastward onto the Colorado Plateau; and 3) the Stability period (A.D. 1300–1850), when the Cerbat and Pai lived in the region where they were observed at first contact with Europeans.

The Cerbat practiced limited agriculture and relied heavily on the gathering of wild plants and hunting. Based on both ethnographic and archaeological data, Matson (1971), Swarthout (1981:63–74), and Wright (1993:16) have hypothesized the following reconstruction of Cerbat and Pai subsistence and settlement. In the winter, small groups of Cerbat and Pai, generally three or four families, established base camps near water sources. In the spring, they dispersed into smaller groups of only two or three families to collect agave, grass seeds, and other wild plants from valley floors and upper bajadas. In the summer, they dispersed still further into groups of only one or two families to collect cactus fruits and mesquite beans, which they processed and cached for use during the winter.

Stone tools found on Cerbat sites include scrapers, knives, triangular basal- and side-notched projectile points, and shallow-basin grinding slabs (Euler 1963:83). Basketry was coiled and twined (Euler 1963:83). Cerbat pottery, Tizon Brown Ware, is reddish brown with granitic rock and granitic sand temper or quartz and feldspar sand temper. Tizon Brown Ware has coiled construction, thinned by scraping and paddle and anvil (Clauss 2001). Tizon Brown Ware is divided into eight types: Cerbat Brown, Cerbat Red-on-brown, Cerbat Black-on-brown, Aquarius Brown, Aquarius Black-on-brown, Sandy Brown, Tizon Wiped, and Orme Ranch Plain (Goetze and Mills 1993:82). Although Griset (1996) directly dated carbon residue on examples of Tizon Brown Ware from southern California to as early as A.D. 545–950, Arizona examples of the ware are poorly dated. Based on the association of Tizon Brown Ware with Lino Gray pottery at Willow Beach (Schroeder 1961), Clauss (2001) suggests that the ware could date to as early as A.D. 700 in Arizona, although he also proposes a beginning date between A.D.

1100 and 1500. Goetze and Mills (1993:82) date the ware after A.D. 1300. Except for Orme Ranch Plain, individual types are not more precisely dated.

Bighorn Cave (Geib and Keller 2002) yielded perhaps the broadest range of Formative material culture of any site in the region from the Grand Canyon to the Bill Williams River and from the San Francisco Peaks to the Colorado River. The assemblage from Bighorn Cave also exemplifies the admixture of cultural traditions in northwestern Arizona during the Formative period. The Formative (cal. A.D. 550–1200) occupation at Bighorn Cave was represented by seven pits and five hearths, along with flaked stone, ground stone, small amounts of pottery, perishables, and human coprolites. Pits were used for storage; several were lined (including one lined with juniper bark). Maize, beans, and squash were present. Wild plants represented by macrobotanical specimens included phragmites, Indian rice grass, dropseed, juniper, buffalo gourd, prickly pear, ceroid cacti, century plant (agave), screwbean mesquite pods, sedge corm, walnut, and mustard. Yucca, agave, and beargrass were used to make artifacts, including two-warp plain-weave sandals and cordage. Wooden tongs, perhaps used to handle cactus, were found. Quids (wads of chewed agave fibers) indicated consumption of agave during this period.

Human coprolites contained mesquite pods, prickly pear stems, yucca buds and flowers, and goosefoot and mustard seeds. A bone bead necklace was also recovered from deposits dating to this occupation. Flaked stone, which included an obsidian arrow point, indicated that although the bow and arrow had been introduced at this time, plant processing was the focus of the Formative occupation of the site.

Three sherds of San Francisco Mountain Gray Ware were present, but only one sherd was from contexts securely dated to the Formative occupation. Lower Colorado River Buff Ware (two sherds of Topoc Buff [A.D. 1000–1300] and three sherds of Parker Buff [A.D. 1050–1800]) were also recovered from the site. Geib and Keller view Bighorn Cave as having been occupied seasonally by Lower Colorado River peoples, harvesting wild plants when they were not farming. As summarized by Geib and Keller, ethnographies describe the Lower Colorado River peoples as being only partly dependent on farming and as living seasonally on the Lower Colorado River in impermanent settlements. They would plant crops on the muddy floodplain after the spring floods, then live in the uplands while the crops matured, then move back to the river for harvest and for the winter, returning to the highlands when the river rose again in the spring.

The site of Boulder Springs, south of Kingman in the Hualapai Mountains, evidenced at least three occupations: ca. A.D. 800 or 900, ca. A.D. 1000 or 1050, and ca. A.D. 1100 or 1150 (Hewitt 1974). The 3,059 sherds from the sites were overwhelmingly Tizon Brown Ware (2,244 sherds), but 330 Lower Colorado River Buff Ware sherds indicated visits by or trade with members of the Lower Colorado River tribes, 72 Prescott Gray Ware sherds represented relations with the Prescott area, 316 San Francisco Mountain Gray Ware sherds represented the Cohonina, 13 San Juan Red Ware sherds were imported from the San Juan River area near the Four Corners, and 12 Tusayan White Ware sherds were imported from east and north of the Little Colorado River (74 sherds could not be identified to ware).

As mentioned above, for the Transwestern Pipeline project, Bair and Stoker (1994) excavated 14 Cohonina/Cerbat sites on the headwaters of the Big Sandy River. The sites were in two clusters: one cluster of seven sites on Muddy Creek and one cluster of seven sites on Willow Creek.

I.3.5 Formative Period Summary

During the Formative period, peoples of the Cohonina, Prescott, and Cerbat cultures used the region from the Grand Canyon south to the Mogollon Rim and Bill Williams River and from the San Francisco Peaks west to the Colorado River. Archaeological sites in the region have yielded evidence that peoples of three neighboring traditions—the Virgin Puebloans, the Kayenta Region Puebloans, and the Lower Colorado

River tribes—traded with the Cohonina, Prescott, and Cerbat peoples in the region during the Formative period.

The Kayenta tradition developed east of the Cohonina, in the region north and east of the Little Colorado River, west of the Chuska Mountains on the Arizona–New Mexico border, and south of the San Juan River. The Kayenta tradition developed out of local Archaic culture and was one of the direct antecedents of modern Hopi culture. Maize was being grown in the Kayenta region by 1000 B.C. (Gilpin 1994; Smiley 1994). The Kayenta people made Tusayan Gray Ware, Tusayan White Ware, and Tsegi Orange Ware (Colton and Hargrave 1937; Hays-Gilpin and Van Hartesveldt 1998; Mills et al. 1993).

The Virgin Branch tradition centered on the confluence of the Virgin and Colorado rivers and extending east across much of the Arizona Strip (the portion of Arizona north of the Grand Canyon). The Virgin tradition probably developed out of local Archaic culture beginning as early as 300 B.C. and continued until ca. A.D. 1200 (Forest Service 1996:14). Much of their gray ware and white ware pottery was similar to Puebloan pottery of the Kayenta tradition or was imported from the Kayenta area (to the east and north of the confluence of the Little Colorado and Colorado rivers). The Virgin Branch made Moapa Gray Ware and Moapa White Ware using olivine temper from the Mount Trumbull area (Bungart 1994a:102; Lyneis 1992, 1995; Samples 1992; Seymour 1997, 2000, 2001, 2004).

As mentioned above in the discussion of Bighorn Cave, the Lower Colorado River tribes practiced farming on the floodplain of the Lower Colorado River, living in temporary villages on the floodplain during the winter, moving to the highlands when the river flooded in the spring, planting crops in the river bottom after the spring floods, living in the uplands while the crops matured, and returning to the river to harvest crops and set up their winter residences. The Lower Colorado River tribes produced Lower Colorado River Buff Ware pottery, which comprises five types (Seymour 1997; Waters 1982).

I.4 PROTOHISTORIC AND HISTORIC AMERICAN INDIANS

I.4.1 Hualapai, Havasupai, and Yavapai

The period from A.D. 1300 to the permanent colonization of the area by Euro-Americans (ca. A.D. 1850) is designated the Protohistoric period. Pai (Hualapai and Havasupai) and Paiute use of the Grand Canyon region, which began after ca. A.D. 1300 (Euler 1958:65–66), was a hunting-and-gathering adaptation supplemented by agriculture (Ahlstrom et al. 1993:82). Although some locations were occupied year after year, dwellings were impermanent wickiups that were rebuilt each year. As mentioned above, the Pai manufactured Tizon Brown Ware; they also made a distinctive triangular projectile point with two notches on each side (Bungart 1994b:64, Figure 4r–t). Euler (1958) excavated 10 sites ranging in date from A.D. 500 to the early twentieth century. Euler's archaeological excavations traced the transition from to prehistory to history among the Hualapai (Euler 1958).

At Bighorn Cave (Geib and Keller 2002), the Late Prehistoric–Protohistoric period (cal. A.D. 1300–1700) was represented by one pit and one roasting pit, along with flaked stone, pottery, and perishables. Among the flaked stone was a Desert Side-notched projectile point. The 14 sherds of Tizon Brown Ware included seven sherds of Cerbat Brown and seven sherds of Aquarius Brown. A Jeddito Black-on-yellow sherd, collected by looters, dates to this occupation and demonstrates trade relations with the Hopi pueblos more than 200 miles to the east. A crude split-twig figurine was also directly dated to this time and was interpreted as an imitation of Archaic figurines.

The Hualapai, Havasupai, and Yavapai languages are a group of related Upland Yuman languages (Kendall 1983). The Hualapai lived in an area bounded by the Colorado River on the north, the Bill

Williams and Santa Maria rivers on the south, the Coconino Plateau on the east, and the Black Mountains on the west (McGuire 1983). The Hualapai were divided into 13 to 14 bands, which were then divided into three larger groups (Dobyns and Euler 1976:16–18). They mixed gardening with hunting and gathered wild plants. Throughout the year, they exploited various resources as they became available. For example, agave would be available in the late spring; in the summer, saguaro fruit would be harvested from Big Sandy Valley and grasses from upland valleys; and in the fall, pinyon nuts would be gathered from the Hualapai Mountains and mesquite from the various canyons (Kroeber 1935; Martin 1985). In addition, during the summer they lived in villages along major streams (such as Matawidita Canyon and Big Sandy Valley) and raised corn, beans, squash, and pumpkins in irrigated fields (Dobyns 1956, 1974a; Euler 1958; Kroeber 1935; McGregor 1935; Spier 1928). The amount of farming versus hunting and gathering may not have been consistent across all the Hualapai and would have varied, depending on how much arable land was within the territories of each group of Hualapai (Martin 1985).

The Hualapai were driven from much of their homeland as a result of conflict with the U.S. Army during 1866–1869, after which they were placed on various reservations, culminating in their current reservation on the south side of the Grand Canyon, which was established in 1883 (McGuire 1983:27). One small (ca. 60-acre) outlying reservation is located on the upper Big Sandy River, just below the confluence of Knight and Trout creeks.

The Hualapai refer to the springs at Grand Canyon West Ranch as *Tanyika Ha'a* (Grass Springs). They held a Ghost Dance at Tanyika Ha'a in 1889 (Dobyns and Euler 1967; Simonis 1998, 2001; Stoffle et al. 2000). Ghost Dances were also held on the plateau near South Parcel by the Hualapai and the Havasupai. The Ghost Dance was a revitalization movement that began among the Paiute and swept through the American Indian tribal communities of the western United States during the late nineteenth century (recently, the movement has been experiencing a rejuvenation, as well). *Wevoka* (the Prophet), who founded the religion, was present at the 1889 Ghost Dance at Tanyika Ha'a.

During the Protohistoric period, the Havasupai's traditional territory stretched from the Grand Canyon south to Bill Williams Mountain and from the Aubrey Cliffs to east of the Kaibab National Forest (Schwartz 1983). Like the Hualapai, there are several theories of the origins of the Havasupai. Schwartz (1955, 1956) posited that they were the descendents of the Formative period Cohonina. Others theorize that both the Hualapai and the Havasupai are the descendents of the Formative Period Cerbat peoples (Euler 1958). During the Protohistoric period, the Havasupai and the Hualapai were then a single tribe; the Havasupai were a band of the larger Pai group that later split off as a result of historical circumstances (Dobyns and Euler 1970; Euler 1958; Kroeber 1935; Stewart 1966). Like the Hualapai, they relied on farming within canyons as well as hunting and gathering on the plateau (Martin 1985; Schwartz 1983).

Early Spanish explorers and later European explorers had some contact with the Havasupai (Dobyns and Euler 1970; Schwartz 1983); however, was not until the nineteenth century that they began to feel real pressure from settlers and miners. In the late nineteenth century, ranchers began to demand more land for cattle grazing in the area used by the Havasupai. In addition, the copper deposits in Havasu Canyon were attracting the attention of miners (Schwartz 1983). Under pressure from the ranchers and miners, the U.S. government established a reservation within Havasu Canyon in 1880; a school and a Bureau of Indian Affairs agency office were established in 1895. The government encouraged the Havasupai to remain in the Canyon year-round and abandon their use of the plateau (Hirst 2006; Schwartz 1983). Although the Havasupai had all but abandoned their traditional hunting and gathering territory by the 1940s, in the 1970s they fought to re-establish territory outside Havasu Canyon. The Havasupai fought for their right to include plateau lands in their reservation and won an expansion of their reservation in 1975 (Hirst 2006).

The Yavapai were one of the primary users of northwest-central Arizona during what is referred to as the Protohistoric period (A.D. 1500–1820). They relied predominantly on hunting and gathering but also practiced some floodwater farming (Braatz 2003; Gilpin and Phillips 1999:66). By the end of the sixteenth century, the Spaniards had made a couple of brief forays into Yavapai territory (Braatz 2003:34–35). By the eighteenth century, the Western Apache had formed a cooperative relationship with the Yavapai and were residing in the Prescott area (Gilpin and Phillips 1999). Fur trappers exploring the Verde Valley in the early 1800s reported that both groups were in the valley (Motsinger et al. 2000). The Apache and Yavapai traded with one another, often collaborating in raids against common enemies, particularly the Pima and Maricopa. Intermarriage sometimes occurred between Apache and Yavapai. When confined to the White Mountain Reservation, intermarriage of these two groups was common (Braatz 2003). The genetic studies mentioned above support these historic accounts about intermarriage between the Yavapai and Apache (Malhi et al. 2003).

By the nineteenth century, the Yavapai themselves comprised four subgroups: Tolkepayas, Yavapés, Wipukepas, and Kwevképayas. The Yavapés occupied the Prescott area. Each subgroup was composed of a number of small bands that varied in size throughout the year. Size was dependent on the availability of resources, such as water, plants, and animals. Although every band made its own alliances, the Tolkepayas, Yavapés, and Kwevképayas all shared a common enemy in the Pima and Maricopa during this century (Braatz 2003). However, years earlier, they had had a civil relationship with these two groups. The Kwevképayas and the Apache were strong allies. The northern Tolkepaya, northern Yavapés, and Wipukepas all shared a common enemy in the Havasupai. Yavapai consultants reported that, not unlike what had happened with the Pima/Maricopa relationship, the Havasupai, Hualapai, and Yavapai had been close friends until an argument over a child’s game created enmity between the Yavapai and the Havasupai and Hualapai (Braatz 2003). As mentioned above, the Tolkepaya and the Quechans in the Colorado River valley enjoyed a relationship of mutual benefit.

I.4.2 Southern Paiute

During the seventeenth century, Spain colonized most of western North America, expanding as far north as present-day California, Arizona, New Mexico, and Texas. Eager to exploit the resources of the new territory, trappers, miners, and missionaries entered these lands and met the inhabitants. Of the many who came to the new world, very few explored the area known as the Arizona Strip, preferring the moderate climate of Santa Fe or the ocean access afforded by California. Those who did pass through the Arizona Strip encountered a people living a subsistence lifestyle in bands of 10 to 50 people (Knack 2001:20).

At contact, the Southern Paiute existed as a dispersed band of kinship-based groups moving seasonally along the landscape. While they subsisted mainly from hunting and gathering, there is ethnographic evidence of small-scale agriculture of squash and corn along riverbanks (Knack 2001:15). Groups would maintain resource areas and use what was locally available to them. There is no ethnographic or written evidence of conflict or warfare among the Paiute or their neighbors prior to contact (Knack 2001:15). Consultants assert that the Paiute would share resources in times of environmental stress and would join other bands until the conditions improved (Knack 2001:15).

The arrival of Europeans had many negative effects for the Kaibab Paiute. Most evident is the loss of life as a result of diseases brought to the New World by the Spanish. The lack of immunity and effective medicines left the Paiute defenseless against the diseases that decimated their population (Fairley 1989b:160). The Spanish had further impacts on the culture through the encouragement of the slave trade, which put the Paiute on the defensive against the neighboring Ute tribe and the more distant Navajo. Normally a peaceful people, the Paiute were not able to adequately defend themselves against the raiding parties. The passage of the Spanish Trail through their homeland made the Paiute a convenient target for the caravans of traders traveling between New Mexico and Arizona. The caravans also brought with them large herds of sheep and horses. The intensive use by livestock despoiled the area around major springs. As a result of these impacts, it was observed that by the early 1800s, some traditional resource areas had been abandoned by the Paiute (Fairley 1989b:160).

The end of the Mexican–American war in 1848 brought a flood of new immigrants to the Southwest from the East. Between 1852 and 1864, Mormon settlers moved into the Arizona Strip region and developed mission communities in the Paiute homelands. The Mormons had established settlements at Short Creek, Pipe Springs, Moccasin Creek, and at Beaver Creek Dam by 1866 (Fairley 1989b:165). Initially, the Paiute welcomed the Mormons, as they hoped that the Mormons would provide a buffer between them and the hostile Ute. However, the peaceful coexistence did not last long, as Mormon cattle ranching destroyed Paiute gathering lands, and they were reduced to begging or stealing cattle to survive.

The interactions with the Mormons initiated cultural changes in the Paiute community. Many converted to the religion in order to obtain goods and gain a share of the Mormons' resources. Those who did not convert formed chiefdoms, a new concept for the traditionally loosely banded group, to facilitate negations with the settlers (Stoffle and Evans 1978:18). Almost all Kaibab Paiute people adopted a new material culture that reflected the lifeways of the settlers. Glass, iron, and steel replaced traditional weaponry materials, and guns became commonplace. Pottery and baskets were replaced by iron and brass containers. Breechcloths and apron skirts traditionally worn by the Paiute were replaced by clothing cast off by the Mormons (McKoy 2000:23).

The U.S. government was made aware of the deteriorating conditions in the Arizona Strip by John Wesley Powell, who made contact with the Southern Paiute during his expedition down the Colorado River in 1869 (Fairley 1989b:176). He was distressed by the condition in which he found the Paiute and propositioned the U.S. Special Indian Agent in 1872 for assistance on their behalf. Powell's notes state, "The Kaibabits are camped three miles from me . . . and I find them in a truly suffering condition. They have exchanged their ornaments and clothing for food and do not have enough" (Fairley 1989b:183). The results of investigations on behalf of the U.S. government were to place the Paiute on the Moapa Reservation created in 1873 in Nevada. The Kaibab Paiute refused to go and faced even more dire straits as a result. By 1880, Jacob Hamblin, a Mormon explorer, sent a note to John Wesley Powell regarding the Kaibab Paiute in which he described them as "destitute" and noted how ranching had destroyed the fertile landscape on which they once thrived (Fairley 1989b:184).

The creation of National Parks and Reserves in the Arizona Strip increased the stress on the Paiute by denying them access to traditional hunting and collecting areas (McKoy 2000:66). The area around Buckskin Mountain was declared a National Reserve in 1893 (McKoy 2000:66). Special Agent James A. Brown noted that "formerly the Buckskin Mountain afforded excellent hunting ground, but since that has been made a forest reserve the Indians have been shut off . . . . Deer are very plentiful on the Buckskin Mountain, and before it was made a reserve these Indians obtained most of their living from that source" (Brown [1903], cited in McKoy 2000:66). This occurred again in 1906, when President Roosevelt declared the Grand Canyon a National Reserve.

Conditions for the Kaibab Paiute remained dire until 1907, when they received a 12 × 18–mile tract of land at Moccasin and Pipe springs from the federal government (Fontana 1998:40). Prior to the official decree, the Paiute had received a small parcel of land and some water rights outside the settlement of Moccasin from the local Mormon community. In 1904, when a special agent to the Kaibab from the government visited the area, he found they had irrigation ditches along Moccasin Springs that supported small-scale agriculture and provided them with a meager means of subsistence (McKoy 2000:51).

The reservation lands provided the Paiute with a means of survival, even if it meant the end of traditional lifeways. At the time, there were about 80 Paiutes in the Kanab area who moved onto the reservation. The federal government set up irrigation pipes, provided cattle, and supplied a school building to the new residents. By 1914, Henry W. Dietz, Superintendent of Irrigation, notes that the Paiute were engaging in dry and irrigation ditch agriculture and cultivating corn and alfalfa (McKoy 2000:77). They were also moderately successful in cattle ranching.

As the region developed, the boundaries of the reservation became a topic of contention. Demands for access to resources and land by the settlers often put the Paiute on the losing end of government deals. In 1913, the General Land Office decided to exclude the town of Fredonia from the limits of the reservation at the request of the townspeople. Extracting it from the reservation allowed the people in the town to make claim to the land for themselves (McKoy 2000:76). The creation of public water reserves within ¼ mile of Canaan Reservoir, Two Mile Spring, and Pipe Spring in 1915–1916 further diminished the Kaibab Paiutes' acreage (McKoy 2000:78). In 1917, the Kaibab Paiute were permanently assigned 120,413 acres in Northern Arizona by President Woodrow Wilson.

In 1923, the National Park Service (NPS) created Pipe Spring National Monument. The Director of the NPS, Stephen Mather, wanted a roadway that would connect Zion National Park with Grand Canyon National Park. Mather envisioned tourists using Pipe Spring as a rest stop on their way between the two large parks (McKoy 2000:94). The ownership of the land and water at Pipe Spring was under dispute, as a local man claimed his family had rights prior to the establishment of the Paiute Reservation there. Maher took advantage of the murky legal situation to rush the establishment of the Monument into legislation. He was able to obtain 40 acres for the National Monument with little regard to the Kaibab Paiute, as "the Indians have no special need for the land," according to Commissioner Charles Burke of the Office of Indian Affairs (McKoy 2000:105). In 1924, the sale of land was completed, despite objections by Dr. Edgar Farrow, the government agent to the Kaibab Paiute at that time, who contested the government's right to obtain the land and water rights from the reservation (McKoy 2000:137). Disputes over water rights would continue well into the 1930s, as the Paiute, NPS employees, and cattle ranchers fought for the right to use Pipe Spring.

The enforcement of Paiute water rights to one-third of the Pipe Spring flow made agriculture a difficult endeavor. A drought that lasted through the 1920s and 1930s, coupled with the Great Depression, made life even more difficult for the Paiute. There was no work outside the reservation as there previously had been. While they did own cattle, their success was minimal and often fraught with land and water conflicts with outside cattle ranchers (McKoy 2000:192).

Outside industries offered the Kaibab Paiute a chance to make an income when their land was not producing. Women sold buckskin and baskets to the tourists passing through Pipe Spring National Monument and took jobs working as maids in hotels. When Hollywood needed backdrops for their Western films, the Kaibab rented land to them and worked as extras on the set. Others took jobs working for the Civilian Conservation Corps (CCC).

The trend of leaving the reservation to look for work continued into the World War II (WWII) era, which saw a migration of Paiute to major cities. Few Paiutes enlisted in the military, but many worked in support service jobs. Most would return to the reservation, eventually feeling that their homeland was the Arizona Strip (Knack 2001:243).

Post-WWII, the federal government instituted many policies that profoundly affected American Indians living on reservations. The Indians Claims Commission Act of 1946 allowed tribes to sue for reparations as sovereign entities for loss of land, unfulfilled treaty obligations, and other claims against the federal government. By 1951, five bands of Southern Paiute tribes, including the Kaibab, filed suit against the federal government for loss of traditional land as a result of unlawful seizure and malfeasance (Knack 2001:246). The amalgamated tribes were successful in their lawsuit and received an $8.25-million settlement in 1964 (Knack 2001:248).

The Kaibab Paiute, in order to join in the lawsuit, had to create a leadership position to represent them in legal matters. As a result, in 1951, they created their first tribal council under the provisions of the Wheeler-Howard Act (1934), which is more informally known as the Indian Reorganization Act. The Act encouraged the creation of a constitution that would have to be approved by the federal government.

In 1965, the Secretary of the Interior approved the Kaibab Paiutes' constitution, thereby making them eligible for federal funding and providing the tribe with a structure for self-government.

I.4.3 Navajo

According to archaeologists and historians, the Navajo, or Diné, are latecomers, compared with other groups in the Southwest; however, according to Navajo culture history they have been here since they first emerged into this world. This disparity of opinion has made specifying when the Navajo arrived difficult; the following account discusses the opinion of archaeologists and historians and does not represent the only version of how the Navajo came to the Southwest. Arriving in the Four Corners region sometime between the fourteenth and sixteenth centuries, the Navajo speak an Athapaskan language that is closely related to populations in western Canada (Correll 1976; Haines 2003; Haskell 1987; Jett and Spencer 1981; Reed and Reed 1996). Debate is centered on the time frame and actual route taken, but most consider the evidence to suggest that the migration started as early as A.D. 1000. Archaeological evidence suggests that they arrived as early as A.D. 1500 (Brugge 1983; Wilcox 1981) and were highly mobile hunters and gatherers. With the intrusion into the region by the Spanish in the subsequent two centuries, the Navajo acquired sheep, cattle, and horses. Some postulate that the Navajo adopted farming after the Puebloan revolt (Haines 2003); however, early Spanish accounts describe the Apaches de Nabajó as a semi-nomadic people who practiced limited agriculture (Brugge 1983). Regardless, by the late 1600s, warfare with the Spanish had forced the Puebloan people to seek refuge with the Navajo, creating a blending of cultures (Brugge 1983).

Warfare with the Utes had forced the Navajo to retreat farther into eastern Arizona by the end of the 1700s, and warfare with the Spanish flared up in the late 1700s, when the Navajo forced out Spanish settlers (Brugge 1983). After the Mexican independence in 1821, many Navajo were captured by slave traders as guns became more available to the traders. Conflicts between the New Mexicans and the Navajo increased into the 1830s and 1840s. With the Treaty of Guadalupe Hidalgo in 1848, the United States acquired California and much of what is now known as the Southwest from Mexico at the end of the Mexican-American War. Soon after, U.S. troops entered Navajo territory.

The Navajos had several violent conflicts with U.S. troops in the following years. These conflicts, the lack of protection from slave raiders, and land pressures created distrust between the Navajo and the U.S. government (Roessel 1983). In 1860, the Navajo attacked and almost captured Fort Defiance; this led to a call for action against the Navajo. In 1863, the U.S. military, headed by General James Carleton and Colonel "Kit" Carson, began a campaign to deport the Navajo to Fort Summer in New Mexico. The subsequent "Long Walk" resulted in the death of hundreds of Navajo during this forced march. As many as 8,500 Navajos were held at Fort Sumner until 1868 (Roessel 1983). Once they were released, they returned to the Four Corners area but found it greatly reduced in size. Only about 10% of the traditional use area was available. Through the late 1800 and 1900s the Navajo manage to acquire more of the land, but it was still less than the area they had originally occupied. When the railroad cut through their lands, they built trading posts to capitalize on tourism and the increasing demand for Navajo weaving and silverwork in the late 1800s and early 1900s.

Unlike other Indian tribes across the United States, the Navajo increased their population significantly during this period. To support these many more people, herds of sheep increased in size and numbers, and by the 1930s, erosion problems were severe. In response, the federal government ordered mandatory sheep reductions between 1935 and 1940 (Kelley 1986). The numbers of stock were reduced by one-third. New Deal jobs provided jobs for the livestock-less Navajo.

The Navajo did not officially become U.S. citizens until 1924 and could not be drafted, so they did not fight in great numbers during WWI. During WWII, however, many Navajo signed up to fight for their country after the attack on Pearl Harbor. The best known Navajo soldiers were the "Code Talkers:" U.S. Marines who used the Navajo language as a basis for sending messages (Oswalt 2006:367).

Wage jobs increased until the late 1940s, and the end of WWII brought on a recession. Federal and mining jobs filled some of the gaps, but because of ever-increasing populations, unemployment has continued to be a problem.

Traditionally, the Navajo maintained at least two seasonally occupied camps. Occupied in either the summer or winter, they were composed of at least one permanent structure and several temporary ones. Families would move between the camps, focusing on agriculture, collecting, and/or herding sheep. Depending on the resource focus, camps would be composed of various structures. According to Cleeland et al. (1992) and Haines (2003), temporary camps were the most common types of sites on the Coconino Plateau.

Prior to the Historic period, the Navajo manufactured basketry and gray to black utility ware ceramics for use cooking, collecting, and storing. These items were no longer in use during the Historic period, when metal and glass containers became available. Following the introduction of sheep in the seventeenth and eighteenth centuries, the Navajo became skilled weavers. Besides the usefulness of having Navajo blankets and rugs around the camp, their talents became highly sought after for the tourist trade. Jewelry manufacture became commonplace during the early twentieth century, and the Navajo became expert silversmiths.

According to Haines (2003), there is some debate about the earliest occupation of the Coconino Plateau. Dendrochronological samples used by the Indian Claims Commission in the 1960s suggest that timbers used in Navajo construction dated to as early as the late 1700s. Euler (1974), however, discounts these early dates, suggesting there was a problem with old wood. He believed that the Navajo first began to appear in small number in the 1860s but were not well established until the 1890s. More recently, other scholars have reviewed the evidence and have come to the conclusion that in fact Navajo settlement was established in the 1700s (Roberts et al. 1995). In any event, some Navajo families made their way onto the plateau in the 1860s as a result of the conflict with the U.S. military and to avoid capture and relocation to Ft. Sumner. By the 1890s, some Navajo had become established along the eastern edge of the Grand Canyon and Coconino Plateau (Euler 1974). Once the Grand Canyon Forest Reserve was established in 1893, the government evicted the Navajo from that area and prohibited sheep grazing in the plateau. As a result of conflicts with Euro-American ranchers over water and lands, the boundary of the reservation was extended twice to alleviate this problem. The first time was in 1900 to the Little Colorado; it was extended again in 1930 to its present boundary along the edges of Grand Canyon National Park and Kaibab National Forest.

Beyond grazing activities, the Navajo seasonally frequented the plateau for pine nut harvests (Cleeland et al. 1992). Early collection of these nuts was probably restricted to consumption by family members. More recently, however, they have been collected for sale to others as a source of income.

I.4.4 Hopi

The area of the villages at Hopi has been continually occupied for at least 1,000 years. Beginning in the late thirteenth and early fourteenth century, people moving into the Pueblo area (including New Mexico) had established several large towns on Antelope Mesa, although it is unclear whether these towns were Hopi (Brew 1979). By the time the Spanish arrived in the sixteenth century, many of these towns had been abandoned and most Hopi settlement could be found on Black Mesa; those pueblos on Antelope Mesa that were not abandoned were Hopi as well. The Hopi were primarily agriculturalist; cultivating corn, beans, and squash on the lands surrounding their mesa. While they were primarily dry farming maize and beans, they did also practice flood agriculture and irrigation farming (Brew 1979). After the initial sporadic contact of Spanish explorers in the sixteenth century, Spanish missionaries established churches at several pueblo communities in New Mexico and Arizona, including the Hopi pueblo of Awatovi (Brew 1979; Clemmer 1995:29). The missionaries were initially successful at Awatovi; they converted many Hopi after the miraculous healing of a blind boy by a cross. Missions established at Oraibi and Shongopavi were less successful; however, the presence of the Spanish brought new material goods such as axes, saws, cloth, and sheet tin to the Hopi towns (Brew 1979). Most of the Hopi continued to resist conversion to Christianity. This resistance to conversion and Spanish influence in general led them to participate in the Pueblo Revolt of 1680 (Clemmer 1995:30; Rushforth and Upham 1992:104). The Hopi destroyed the churches and killed the five Spanish priests in their villages (Brew 1979). The Hopi remained relatively isolated after the revolt; although there were several attempts to conquer the Hopi, the Spanish never re-established themselves at Hopi (James 1974:59–70).

After Mexican independence, the Navajo increased their raiding activities on the Hopi, taking livestock and selling it to dealers to the east (James 1974:71–72). The Navajo even managed to drive off or kill most of the inhabitants of Oraibi in 1837. Other tribes and Mexicans also conducted raids on the Hopi for food, livestock, and slaves (James 1974:72).

The U.S. took control of the Southwest after the Mexican-American War. After 1850, the Hopi began to feel pressure from the influx of new settlers, primarily in the form of smallpox epidemics that greatly reduced the Hopi population (Dockstader 1979). Navajo raiding on the Hopi and droughts were also having an impact on Hopi life (Clemmer 1995:36). As a result, the Hopi helped the U.S. government as Army volunteers to capture and move the Navajo out of Pueblo territory (James 1974:80–81). In the 1870s, new missionaries from the Moravian, Mormon, and Baptist churches established churches in or near Hopi towns (Bailey 1948:349; Clemmer 1995; Dockstader 1979). Not long after, white settlers began to encroach on Hopi lands. Several towns were established by Mormons, and the Atlantic and Pacific Railroad (A&PRR) was built south of Black Mesa (James 1974:100). It was recommended that a reservation be established to stop the encroachment.

The Hopi reservation was established in 1882 on 2.45 million acres; however, this was done without consulting the Hopi, and little was done to enforce the boundaries once they were established (James 1974:101). The U.S. government increased its presence at Hopi with schools and Bureau of Indian Affairs offices. Factionalism between those opposed to the outside influence and those in favor of it eventually led to a split in the tribe at Oraibi in 1910 (Clemmer 1995:110; Dockstader 1979; Rushforth and Upham 1992:127–129; Titiev 1944:110). During the beginning of the twentieth century, more changes led to the decline in population at some towns and the establishment of new towns. Navajo encroachment on Hopi land was leading to tensions between the Hopi and Navajo. In the 1930s, the Hopi reservation was effectively limited to 750,000 acres surrounding their villages when grazing districts were created out of the Hopi and Navajo reservations (Clemmer 1979, 1995:167). Settlements in the case have increased the current Hopi reservation to 1.5 million acres; however, the dispute over land and resources rights between the Hopi and Navajo is still underway today.

Hopi economic development after WWII has included oil, gas, and mineral exploration, as well as tourism (Clemmer 1979). Although several factions within the Hopi Tribe have opposed it, strip mining for coal has become the primary income for the tribe. Currently, the Navajo Generating Station is the sole buyer of coal from Black Mesa.

I.4.5 Zuni

In the beginning of the Protohistoric period, pueblos in other areas were abandoned in favor of new settlements in the area of modern Zuni occupation, although the exact timing of when these new pueblos were founded is still being debated (Kintigh 1985, 2007; Mills 2002). Like the Hopi, the Zuni were primarily agriculturalists, growing maize, beans, squash, and other domesticates. In the sixteenth century, the Zuni's initial contact with Spanish entradas looking for the legendary Seven Cities of Gold was violent and exploitative (Woodbury 1979). Spanish explorers intent on finding riches in the Southwest often embarked on their journeys with insufficient supplies. Upon reaching pueblo settlements in what is today New Mexico, they would demand food and clothing from the pueblos; if these supplies were not forthcoming, there would be violence (Knaut 1995). In the seventeenth century, Spanish attention turned to conversion of the Indians to Christianity, and several missions were established in Zuni towns (Knaut 1995; Woodbury 1979). The presence of the priests in the towns was not universally welcomed; the first mission was built in 1632, but the priest was killed by the Zuni not long after (Woodbury 1979). In the following years, tensions between the Spanish and the Zuni continued to build. Like most of other pueblos in the area, the Zuni participated in the Pueblo Revolt of 1680 (Hackett 1942; Knaut 1995; Woodbury 1979). After the Pueblo Revolt of 1680, many Zunis fled to defensive positions fearing that the Spanish would attack in retaliation. When they returned, they only occupied the town of Zuni and did not return to the five other towns. With a few exceptions, outside contact with the Zuni was minimal until the mid-1800s. Many Zuni began establishing "summer villages" away from Zuni near cultivable lands; Zuni would live in these villages during the summer and would go back to Zuni in the winter (Woodbury 1979). Some efforts were made to re-establish missions at Zuni after the revolt, but these were unsuccessful.

During Mexican control of the Southwest, little contact occurred between the Mexicans and the Zuni (Eggan and Pandey 1979). Like the Hopi, Navajo raids impacted the Zuni during this time. After the United States acquired the Southwest in 1848, contact between the Zuni and Euro-Americans increased with the arrival of travelers moving west in search of gold, settlers moving into the area, missionaries, and anthropologists. In the 1860s, a few towns with Spanish-speaking inhabitants began to appear near Zuni territory, and by 1881 the railroad had opened up access to the area to whites (Eggan and Pandey 1979; Woodbury 1979). Like other groups in the Southwest, smallpox epidemics greatly reduced their numbers in the nineteenth century (Eggan and Pandey 1979). Internal conflicts involving witchcraft accusations at Zuni led the Bureau of Indian Affairs to send in soldiers in the early 1900s (Eggan and Pandey 1979). Traditional ceremonialism remained important to Zuni culture, and efforts to establish Christian churches were met with resistance (Eggan and Pandey 1979; Trotter 1955). A Catholic mission was successfully established in 1922, but its presence split the Zuni into pro- and anti-Catholic groups. This division solidified into political parties over the years; however, few Zuni actually converted to Christianity.

Over time, the Zuni added to their original 1689 Spanish land grant of approximately 17,000 acres; the Zuni reservation today totals about 450,000 acres (Eggan and Pandey 1979; Pueblo of Zuni 2010). In the early 1900s, the Black Rock Dam and new irrigation systems were constructed for Zuni farmers (Pueblo of Zuni 2011). Silver jewelry manufacture became increasingly important after 1925, and by WWII, the sale of jewelry created the majority of Zuni income (Pueblo of Zuni 2011). After WWII, the Zuni expanded their support of silver jewelry manufacture, for which the Zuni are now known (Eggan and Pandey 1979).

I.4.6 Historic Period Euro-Americans

Euro-American knowledge of the region from the Grand Canyon south to the Mogollon Rim and Bill Williams River and from the San Francisco Peaks west to the Colorado River dates to the sixteenth century, when Spanish explorers traveled the area, searching for gold. Subsequently, additional Spanish explorers, American fur trappers, and U.S. military expeditions and surveyors investigated the area. In the late nineteenth century, the region became a major transcontinental transportation corridor and was soon colonized by miners and ranchers.

I.4.7 Spanish Exploration

In 1540, Francisco Vasquez de Coronado went to find the Lost City of Cibola. He did meet the Pueblos in the Rio Grande Valley and was told of a great city northwest of Zuni. Coronado sent Captain Pedro de Tovar to the area that the expedition called the Tusayan Provence. Tovar found the Zuni Villages but was disappointed. He was told of a great river to the west and upon his return relayed this information to Coronado. Excited upon hearing this, Coronado sent another of his men, Garcia Lopez de Cardenas, to investigate. He traveled west to the Hopi Mesas, where he found the people to be welcoming. They agreed to supply his men with provisions in order for Cardenas to continue across what is now Kaibab National Forest to the Grand Canyon. Colton (1946) believed that they probably used one of the Hopi trade routes across the Coconino Plateau through the Coconino Basin and along the south side of Red Butte. They probably reached the Grand Canyon at the present location of the Grand Canyon Village. They were unable to descend to the bottom. Other than what must have seemed like endless forests, they did not find or hear of the vast riches they were seeking.

In 1598, Oñate colonized New Mexico and began exploring the Southwest. In 1604, Oñate traveled from the Rio Grande to California by way of the Bill Williams River. Two accounts of the trip have been published, one by Fray Gerónimo de Zárate Salmerón (Bolton 1916:269), the other by Fray Francisco de Escobar (Hammond and Rey 1953:1015).

In summer 1776, Father Francisco Garcés of the Yuma mission journeyed to Hopi. He traveled up the Colorado River to the vicinity of present-day Kingman (Garcés 1900:420 n. 5, 422; Walker and Bufkin 1986:13). Near the vicinity of modern-day Kingman, Garcés crossed the Colorado and headed east to Hackberry and Peach Springs, stopping perhaps at Truxton Spring. After making a detour to Havasupai, he continued on to Hopi. At Oraibi, he was at first ignored, then expelled, and was finally forced to retrace his steps to Yuma.

Later that summer, Fathers Francisco Atanasio Domínguez and Francisco Silvestre Vélez de Escalante, along with eight others, left Santa Fe, New Mexico, to scout a route from Santa Fe to Monterey, California (Vélez de Escalante 1996). Now known as the Domínguez-Escalante Expedition, the priests traveled north of the Grand Canyon in an attempt to find an overland route between Santa Fe and the Spanish colonies on the California coast (Vélez de Escalante 1996). During their time in the Arizona Strip area, they camped in House Rock Valley with the Paiute. Escalante's journals have provided information about the Arizona Strip and the Southern Paiute who inhabited the region at the time.

By the early 1600s, the Spanish empire had begun to exhibit signs of decline, and in the frontier areas under their control, native populations were becoming tired of Spanish hostilities. The culmination of this unrest, the Pueblo Revolt of 1680, resulted in the expulsion of the Spanish from Arizona, New Mexico, and part of Texas for roughly 20 years (Knaut 1995).

I.4.8 Mexican Period

Mexico won its independence from Spain in 1821. The Mexican government however, sponsored few expeditions into western Arizona. Despite Mexico's attempts to discourage incursions into its territories by citizens of the United States, fur trappers continued exploring the Southwest while it was still part of Mexico. Some of these trappers explored the Grand Canyon region. Although most left no records of their explorations, the several trips that have been reconstructed demonstrate the growing Euro-American knowledge of the region, which would be put to use when former trappers like Antoine Leroux guided U.S. military expeditions through the region in the 1850s.

In fall 1826, four groups of trappers traveled to the Gila River. One group, led by Antoine Robidoux, was attacked by Native Americans on the Salt River. Only three survivors, Robidoux, James Ohio Pattie, and an unnamed French trapper, survived. They then joined up with Ewing Young's party (Weber 1971:119–120, 123). The combined Young and Robidoux parties continued down the Gila River to the Colorado River.

In September 1827, Young and Sylvester Pattie led a group of 24 men, "including servants and campkeepers," to the Gila and Colorado rivers. "They followed the usual route—to the Copper Mines, down the Gila to the Pima Villages" and then to the Colorado River (Camp 1966:43). At the Colorado River, Sylvester Pattie, James Ohio Pattie, and six others "became insubordinate, and parted from the main body" (Camp 1966:45). The rest of Young's group continued along the route followed in 1826, going up the Colorado River to the vicinity of present Lake Mead, returning to the Mohave Villages, traveling overland to the Grand Canyon (at the mouth of Spencer Canyon), then to Grand Falls, Hopi, Zuni, Laguna, and Taos (Camp 1966:53–54; Weber 1971:140–141).

I.4.9 U.S. Exploration and Transportation

Prior to the Mexican War of 1846, very few Americans traveled in northern Arizona. One exception was Jedidiah Smith. In 1826, Jedidiah Smith followed the Old Spanish Trail across the northeast corner of Arizona into what is now southern Nevada. Among other things, he noticed the presence of prehistoric salt mines in the Muddy and Virgin river region. These were to be explored at a later date by Harrington (1926).

Formal military exploration and survey of the Grand Canyon region began after the United States acquired the Southwest from Mexico in the Mexican War. In 1851, Lorenzo Sitgreaves was the first to conduct a survey. He was ordered to see whether the Zuni River provided a feasible route from Fort Defiance and Zuni Pueblo to the Colorado River at Camp Yuma. It was thought that the Zuni River flowed straight into the Colorado River south of the Grand Canyon, but, as Sitgreaves was soon to learn, the Zuni River was a tributary of the Little Colorado River (Wallace 1984:325–326). Guided by Antoine Leroux, Sitgreaves left Zuni on September 24, 1851, and traveled down the Zuni River to its confluence with the Little Colorado east of the South Parcel. The expedition followed the Little Colorado River to Grand Falls and then turned west, traversing the volcanic field north of the San Francisco Peaks. From Bill Williams Mountain, the Sitgreaves Expedition continued west past present-day Ash Fork, Seligman, and Peach Springs, stopping for two days (October 30 and 31, 1851) at Truxton Springs (Camps 27 and 28). Arriving at the Colorado River near present-day Bullhead City, Sitgreaves traveled down the east bank to Camp Yuma (Sitgreaves 1853).

In 1853 and 1854, François Xavier Aubrey, a Santa Fe trader who had gained fame for his rapid transits of the Santa Fe Trail, made trips across northern Arizona. Both times, he drove sheep from New Mexico to California along Cooke's route through southern Arizona and returned to Santa Fe by more northern routes to see whether they would be suitable for wagons or railroads (Bieber 1938).

From 1857 to 1859, Edward Fitzgerald Beale made two round trips across northern Arizona, surveying the route for a wagon road. The Beale expeditions traveled almost the same route as Sitgreaves, skirting the northern headwaters of the tributaries of the Big Sandy River. On the first trip, in 1857, Beale famously brought along camels in order to test their suitability as pack animals for travel in the deserts of the Southwest. Beale repeated his 1857 trip in 1858 and 1859, this time without camels. Along the way, he improved the road he had pioneered in 1857 (Beale 1858, 1860; Stacy 1970; Thompson 1983).

In 1857 and 1858, Lieutenant Joseph Christmas Ives explored the Colorado and Little Colorado rivers. Ives left the mouth of the Colorado on November 28, 1857, took a boat up the Colorado River as far as

Black Canyon (downstream of present-day Lake Mead), and then went overland, descending Diamond Creek into the Grand Canyon. He went southeast, skirting the south side of the San Francisco Peaks (Ives 1861:116).

In May 1863, gold was discovered in the area that would become Prescott. This discovery and the impending Civil War led the Union Army to develop a road from Santa Fe to central Arizona. In June 1863, Captain Nathaniel J. Pishon was to escort surveyor John A. Clark through northern Arizona.

They were to develop a road from the Beal Wagon Road to the gold fields to the south. The route selected was through the southern Kaibab National Forest between present-day Flagstaff and Prescott. The route connected Ft. Wingate in the New Mexico Territory to Ft. Whipple in Arizona.

In 1867 and 1868, William Jackson Palmer conducted surveys along the 32nd and 35th parallels to evaluate these routes for the Kansas Pacific Railway from Sheridan, Kansas, to the Pacific Ocean at either San Diego or San Francisco (Palmer 1869).

In 1862, Mormon explorer, missionary, and pioneer Jacob Hamblin explored the area (Bailey 1948; Simonis 1998, 2001). Crossing the Colorado River at modern-day Pearce Ferry, Hamblin traveled south, apparently to Tanyika Ha'a in Grapevine Canyon, at what is now the Grand Canyon West Ranch. Hamblin wrote, "The first day [after crossing the Colorado] we traveled south up a wash [Grapevine] for about 30 miles. We then traveled three days through a rough, bushy country" (Bailey 1948:251).

In the years after the Civil War, the federal government launched a concerted effort to survey the American West through four government expeditions, led, respectively, by John Wesley Powell, Ferdinand V. Hayden, Clarence King, and George M. Wheeler (Bartlett 1962). Dubbed the era of the "Great Surveys of the West," beginning in 1867, John Wesley Powell led a led a series of expeditions into the Rocky Mountains and around the Green and Colorado rivers. In 1869, he and his party set out to explore the Colorado River and the Grand Canyon (Bartlett 1962). Powell retraced the route in 1871–1872 with another expedition, producing photographs (by John K. Hillers), an accurate map, and various papers. In 1875, Powell published a book based on his explorations of the Colorado River that was originally titled *Report of the Exploration of the Colorado River of the West and Its Tributaries;* the book was revised and reissued in 1895 as *The Exploration of the Colorado River and Its Canyons* (Powell 1967 [1895]).

The Wheeler Expedition explored the region in 1871 and apparently stopped at Tanyika Ha'a in Grapevine Canyon (Simonis 2001; Wheeler 1872:86). The Wheeler map shows a trail running south from what is now Pearce Ferry into what is now called Grapevine Canyon to "Tin-nah-kuh" Spring and then back out into the Hualapai Valley. These surveying expeditions were ultimately replaced, in 1879, by the USGS (Bartlett 1962).

Other military and civilian geographical and exploratory surveys provided information on the region and its inhabitants during the mid-1800s (Ives 1861; Simpson 1876; Wheeler 1872, 1875, 1889; Whipple 1856). Two others reported on American Indian groups in the surrounding areas, including southern Nevada and the adjacent Colorado River: Hoffman (1878) and Whipple (1856). These reports documented the Chemehuevi and the Southern Paiute bands living in the Las Vegas area at Las Vegas Springs, Muddy River, and Ash Creek in southern Nevada and along the Santa Clara and Virgin rivers in southern Utah. These studies are important because they provide the means for comparative study with the Historic period Paiute in the proposed withdrawal area.

In 1874, the Historic Temple Trail was built between Mt. Trumbull and St. George and cuts through House Rock Valley to haul lumber. Portions of this road later became known as the Honeymoon Trail because it was reported to have been used by young couples on their way to St. George to be married in the Temple and to return home.

Beginning in the mid-nineteenth century, livestock were herded from New Mexico into what is now the Kaibab National Forest. More than 551,000 sheep crossed this area on the way to California. The herders, traveling west, returned later to settle in these forests, and the West's cattle industry boomed by the 1870s. Money was to be made feeding miners, and many ranchers established ranches here. By the 1880s, permanent ranches were springing up.

The transition from the trails shown on Wheeler's map to the roads shown on Powell's map was part of a generally improving transportation network in the 1870s and 1880s. Sometime after 1875, Harrison Pearce established Pearce Ferry (Simonis 1998, 2001). Completion of the A&PRR's transcontinental route through northern Arizona in 1883, combined with various federal settlement and reclamation programs, accelerated the economic growth and development of the Grand Canyon region.

The A&PRR's construction of a line across Arizona might not have occurred if other railroads had not interceded with partnerships and funding (Janus Associates Inc. 1989). The A&PRR had been chartered in 1866 by Congress to build a line from Spring Field Missouri to the Colorado River and then to San Diego. The route was to generally follow the 35th parallel across Arizona. Unfortunately, the A&PRR went bankrupt in 1876 after completing only 361 miles of track from St. Louis westward, falling far short of the Arizona–New Mexico section. The company came into possession of the St. Louis and San Francisco Railroad (SL&SFRR), which itself was suffering from money troubles. In November 1879, the SL&SFRR, A&PRR, and Atchison, Topeka & Santa Fe Railroad (AT&SFRR) teamed up to complete the line to the West Coast. The AT&SFRR had the funds, and the A&PRR held the deed to the right-of-way west of Albuquerque.

As soon as the agreement was signed by the three companies, the AT&SFRR began to prepare for construction. A route was selected along the Rio Puerco to Holbrook to Kingman in part because of the earlier Whipple surveys, which were used as a guide and by the Union Pacific Railroad surveys across the area. Starting in Isleta, New Mexico, construction began in summer 1880. Contracts had already been signed between local companies along the route to clear, grade, and supply ties. Camps were established, and workers were hired to complete the line. Lewis Kingman ran the project by first leading the survey crews and then the construction itself. The track was finished to Holbrook in July 1881, but flooding prevented the first train to run until mid-September of that year. The tracks were completed to Winslow in December 1881. By August 1882, track layers had reached Volunteer, now called Bellemont, and the track reached Williams in September. Because of several tunnels and bridges west of Williams, the line did not reach Needles until August 1884, where it joined with the Southern Pacific Railroad. Although they were not major hubs like Winslow or Needles, Flagstaff and Williams did offer support services for the railroad, with structures at each stop.

Unfortunately, the line did not have the traffic that had been projected. Maintenance was deferred, leaving some of the wooden bridges to deteriorate and the bed itself to become eroded. In the mid-1890s, Edward P. Ripley bought the railroad and immediately began to refurbish it. He replaced cars, track, and all the wooden bridges with steel, including the 1,100-foot bridge across the Colorado River at Needles.

Fred Harvey was associated with the AT&SFRR as early as 1876, when he opened a lunch counter in Topeka. With success with this venture, he soon opened several restaurants and hotels along the line. Restaurants opened in Holbrook, Winslow, Williams, Ash Fork, Seligman, and Kingman. Next were resort hotels; the one in Williams was called the Fray Marcos. At the Grand Canyon, the El Tovar and the Bright Angel Lodge were constructed.

Prior to World War I (WWI), there were few roads providing access to the forests, and most of these were leftover, badly eroded trails that had been logging roads. By 1901, officials of the forests had concluded that they needed better access for management of the forests and protection from fire. The first federal funding for roads here was in 1910. Between 1910 and 1920, with the increase in automobiles, roads were being constructed across the region. By 1926, the volume of automobile traffic and their passengers surpassed what the trains brought to the Grand Canyon. The Federal Aid Road Act of 1916 provided matching funds to construct roads. The Old Trails Highway was built by the state this way; it followed the approximate path of the Beal Wagon Road. In 1926, the road was designated U.S. 66 (Route 66). Route 66 between Chicago and Los Angeles was paved by 1938. This 2,282-mile-long route was the nation's first completely paved transcontinental highway (Putt 1991).

In 1919, a road between Williams and the Verde Valley was proposed. Funding for this road was continually diverted for improvements to Route 66, however. A paved road between the Grand Canyon and Williams was proposed in 1925. This would replace the existing trail to the Bright Angel area. Unfortunately, it was not until the problem with ownership of that location was resolved that construction of the road began. It was begun in 1928 and was completed on Christmas Eve in 1930.

In May 1930, Congress passed the Colton-Oddie Bill, authorizing $3.5 million in funding for forest road and trail development. In April 1931, the U.S. Department of Agriculture announced that they had $560,000 for forest highways. With the onset of the Great Depression and the CCC, road building began in earnest.

Air flight began with the permitting of Scenic Airways to establish a landing field near Red Butte. The Grand Canyon Airport was used until the 1960s, when a new airport used today was built south of the village of Tusayan. The Grand Canyon Historic Airport District was listed in the NRHP in 2007.

I.4.10 The Forest Reserves and the Forest Service

In 1873, Congress passed the Timber Culture Act, and in 1880, they passed the Timber Cutting Act. These acts promoted the removal of timber from public lands for domestic and mining uses. After 1890, however, when John W. Powell's report to Congress on the state of the forests was issued, foresters and researchers pushed for action to fix the problem these acts had created. Powell revealed that the forests were in a serious state of decline and posed a serious environmental and economic threat to the country. In response, the Congress passed the Forest Reserve Act of 1891, which gave the authority for the President of the United States to set aside forests in order to manage their natural resources. This was the beginning of the forest reserves, and in 1893, President Benjamin Harrison passed a proclamation establishing the Grand Canyon Forest Reserve (Putt 1991).

In 1898, President William McKinley set aside more lands in northern Arizona as the San Francisco Mountain Forest Reserve. The forest reserves were transferred from the U.S. Department of the Interior to the Forest Service. In 1908, the area above the Colorado River became the Kaibab National Forest; the Tusayan National Forest, headquartered in Williams, was established in 1910. Grand Canyon National Park was created in 1919, which substantially reduced the size of the forest. In 1934, the Tusayan and Kaibab national forests were combined to create the present-day Kaibab National Forest.

I.4.11 Grand Canyon National Park

The establishment and evolution of Grand Canyon National Park began with the increasing interest with tourism in the late nineteenth century. The administrative history of the Park is detailed in Anderson (2000); a short synopsis is presented here.

In the late 1880s, the Grand Canyon attracted miners, ranchers, and entrepreneurs seeking to make their way in the West by obtaining lands from the federal government. Prior to the 1880s, wagon roads were the only real access to the areas, making settlement sporadic; however, the completion of the A&PRR, which was owned by the AT&SFRR, to the area in 1882 made travel to and from the Grand Canyon area easier and ushered in a new business in the West—tourism (Anderson 2000:2–3). Several new towns were settled along the rail line, which attracted new businesses to the area. Mining became more profitable as the railroad decreased shipping charges, ranching became big business, and lumber companies set up to supply wood for railroad facilities and other buildings and structures (Anderson 2000:3). Some of these early pioneers, such as William Wallace Bass, also set up tourism businesses, guiding people on excursions to and down into the Canyon. One group who later created problems consisted of Pete Berry and Niles and Ralph Cameron; they had control of the Bright Angel Trail from the rim to Indian Gardens, which they ran as a toll road. James Thurber built the Bright Angel Hotel at the head of the trail on the rim in 1896, and in 1901 a rail line from Williams to the Bright Angel Trail, Grand Canyon Railway, was completed, allowing even more tourists to journey to the Canyon (Anderson 2000:4–5).

The stage was set for the creation of the Grand Canyon National Monument and later the national park beginning in the 1890s in Washington, D.C. As noted above, Congress passed the Forest Reserve Act in 1891, which allowed federal forest lands to be set aside by the president. This allowed President Harrison to set aside the Grand Canyon Forest Reserve in 1893, portions of which were later declared a game preserve by President Theodore Roosevelt (Anderson 2000:7). In 1906, Congress passed the American Antiquities Act, which allowed presidents to declare places national monuments in order to preserve their historic or scientific value. President Roosevelt declared 1,279 square miles of the Grand Canyon the Grand Canyon National Monument in 1908 (Anderson 2000:7–8). The Grand Canyon Forest Reserve was renamed the Grand Canyon National Forest and taken over by the Forest Service in 1907; the monument was added to the Forest Service's care the next year. At this time, the Forest Service had very little in the way of amenities for visitors to the Grand Canyon; most facilities were owned and operated by the AT&SFRR, the Fred Harvey Company, and a few smaller independent operators (Anderson 2000:9–10).

In 1916, Congress created the NPS; in 1919, the Grand Canyon was transferred to the NPS and designated a national park. The NPS, along with its first director Stephen Mather, was very interested in promoting tourism to its parks. It promoted development of new roads to the parks to accommodate tourists and launched a See America First ad campaign to urge Americans to visit their own wonders rather than travel to Europe. In 1919, William Harrison Peters became the Grand Canyon National Park's first superintendent and began the task of upgrading what facilities the NPS could; however, most facilities will still provided by the outside sources noted above (Anderson 2000:13–14). Even with the many vendors competing for tourist business, visitors to the Grand Canyon suffered from shortages of housing options and unsanitary conditions. The Park did provide rangers to enforce laws and regulations and utilities such as new phone lines. Peters also had several new buildings constructed, such as a warehouse and a mess hall for employees (Anderson 2000:17). Peters' successors continued to construct other facilities to house and feed the growing workforce at the Park. The Park's first master plan was completed in 1924; the plan focused on development at the Grand Canyon Village, and although many of the ideas in the plan could not be constructed right away, the plan continued to guide development at the Park into the 1950s (Anderson 2000:18). Other developments within the Park included the construction of new trails, roads, and campgrounds to accommodate the growing number of tourists arriving by automobile in the 1920s and 1930s. The new trails included the South Kaibab Trail, which was completed in the 1920s and was designed to bypass the Bright Angel Trail (Anderson 2000:20–23).

In the 1930s during the Great Depression, the Park benefited from New Deal programs such as the Public Works Administration and the CCC (see above). The CCC began arriving in 1933 and began maintenance, construction, and conservation programs throughout the Park (Anderson 2000:26). Vendors in the Park suffered as a result of the downturn in tourism during the depression; some projects did move forward, like the Utah Parks Company water system on the North Rim and the AT&SFRR's new water system from Indian Gardens to the Grand Canyon Village (Anderson 2000:27–28). Along with new infrastructure, educational programs began to rise in importance in the Park; for example, the Park began to develop more lectures and exhibits and to train more rangers in educating the public. Residents of the Grand Canyon Village also became more interested in education and in 1932 began the Grand Canyon Natural History Association, which later became the Grand Canyon Association (Anderson 2000:34). Other important developments in the 1930s included the addition of several square miles to the Park itself and the creation of the Grand Canyon National Monument in 1932 (Anderson 2000:38).

Like the rest of the country, during WWII the NPS and the Grand Canyon National Park did their part to assist with the war effort, although Grand Canyon National Park was not as heavily used by the military as other parks. The Army used the recently abandoned CCC camps to house troops coming to the Park for recreation but not for training (Anderson 2000:42). Government austerity measures cut down on the number of Park staff during the war, putting strain on some facilities, and overall visitor numbers were down (Anderson 2000:42). Starting in 1945, after the war was over, visitation to the Grand Canyon National Park once again picked up, and by 1948 more than 600,000 people visited the Park each year (Anderson 2000:44). The influx of visitors prompted more infrastructure development, including a new electric transmission line built by Arizona Public Service (Anderson 2000:49). Starting in the 1950s, the demand for services at national parks prompted the NPS to institute a massive building program called Mission 66, which would continue until the 1980s (Anderson 2000:57).

At Grand Canyon National Park, a new Mission 66 prospectus was developed that became the Park's Master Plan into the 1970s. New facilities such as the Grand Canyon Visitor Center, new campgrounds, and new sewer and water lines were built either by the NPS or through contracts with local companies (Anderson 2000:58–59). Over the next few years, the Park kept up facility development mainly on the South Rim; facilities on the North Rim were primarily the responsibility of the Utah Parks Company until they donated all North Rim facilities to the Park in 1972 (Anderson 2000:61). The Park boundaries continued to be defined and expanded, culminating the addition of the Grand Canyon National Monument and the Marble Canyon National Monument to Grand Canyon National Park in 1972 (Anderson 2000:67).

I.4.12 Timber and the Forests

Since the 1880s, the timber industry has been a primary industry in forested areas south of the Grand Canyon within the proposed withdrawal area. Logging and the necessary supporting infrastructure, such as rail lines, water works, and power-generating plants, sustained more than half of the workforce in both Flagstaff and Williams during the first part of the twentieth century (Stein 2006:5).

At first, lumber companies used horse and wagon to haul logs to the mill. As the timber was depleted, the mill was moved to the next location (Plummer 1904:14). Initially, the only market for lumber in the region was for mining. It was not until the railroads began building in earnest that the need for lumber for ties became paramount. In addition, once the rail lines were in, shipping lumber to other markets became feasible.

In 1880, construction began on the A&PRR, a subsidiary of the AT&SFRR. The A&PRR stretched across northern Arizona, passing through Flagstaff and Williams on its way from Albuquerque to Needles. Construction of the railroad to Flagstaff was completed in 1882. The A&PRR created a demand for ties, as many as 3,400 per mile, that was met in part by local lumber companies along the route. A secondary supporting market blossomed, supplying rails and other hardware, locomotives specific to moving logs over short distances, lumber equipment, and all the supplies necessary to keep logging crews fed and clothed. The A&PRR through Flagstaff became the AT&SFRR in 1902 (Hardy 2010).

Timbering first started south of the Grand Canyon in the 1880s to supply the mines near what would become Prescott after timber resources in the Prescott area had been depleted. While many of the logging companies in the Prescott area went out of business with the depletion of timber resources, W. Z. Wilson and Alvin Haskell moved their operation from Prescott to the forests surrounding Williams and Chalender and opened a mill near present-day Dogtown Reservoir. In 1881, Chicago industrialist Edward Everett Ayer received timber rights along the A&PRR right-of-way and established the Ayer Lumber Company, which was awarded a contract to supply railroad ties and other lumber to the A&PRR and to supply ties and telegraph poles to the Mexican Central Railroad. Ayer opened a sawmill in Flagstaff two weeks before the A&PRR reached town and subcontracted with other mill operators such as Wilson and Haskell to meet demand (Stein 2006).

By the late 1880s, the transcontinental AT&SFRR and its subsidiaries had created an enormous market for lumber locally and nationally. In addition, manufacturers had developed locomotives and other devices suited for lumbering. The so-called “timber barons”—individual landowners who had purchased land with timber rights prior to the construction of the railroad—were free to clear-cut the land on which they held timber rights; logging companies purchased their timber rights from the transcontinental railroads, which had been granted alternate “checkerboard” sections of land from the federal government (Stein 2006).

In 1886, Ayer sold his company to his manager, D. M. Riordan, who formed the Arizona Lumber Company. Riordan and his associate Francis Hinckley acquired the Arizona Mineral Belt Railroad in 1888; the railroad had been completed between Flagstaff and Mormon Lake in 1887. Soon after, the Mineral Belt was renamed the Central Arizona Railway, and a network of spurs was constructed off the main line to harvest timber south of present-day Lake Mary. The company reorganized in 1890 as the Arizona Lumber and Timber Company. The Arizona Lumber and Timber Company built and operated numerous mainlines and spurs under the name Central Arizona Railway from 1889 to 1937, reaching to Clark Valley, Rogers Lake South, Greenlaw North, Greenlaw South, Rogers Lake North, Woody Ridge, and Munds Park-Howard Spring (Stein 2006).

In 1893, the Saginaw Lumber Company purchased timber rights to thousands of acres of former A&PRR land and constructed mills in Williams and Chalender. The company became the Saginaw and Manistee Lumber Company after a merger in 1899. From 1898 to the 1940s, the Saginaw and Manistee Lumber Company built and operated railroads to access timber south of Williams, north of Chalender, north of Bellemont, south of Garland Prairie, south of the Grand Canyon, and south of Mormon Lake (Stein 2006).

The Flagstaff Lumber Manufacturing Company (Flagstaff Lumber Company) was established in 1909 by Ed McGonigle, who had been the general superintendant of Arizona Lumber and Timber Company’s Flagstaff Mill. In 1910, the company completed construction of the Flagstaff & Southern Railroad from Flagstaff to Clark Valley. Other lines were constructed to reach timber stands at Howard Mountain, Anderson Mesa, and Mormon Mountain between 1910 and 1927, when the company was purchased by the Arizona Lumber and Timber Company. Loggers were housed in logging camps close to the areas being cut. Camps were usually portable and were moved to a new area once an area was depleted. The camps served as fueling and repair centers for workers, locomotives, and horses. In addition to loggers and railroad mechanics, blacksmiths were housed at the camps to keep the horses properly shod and to repair logging machinery. As the camps were temporary, most are evidenced today by food-related trash scatters resulting from the enormous quantities of food consumed by hard-laboring logging crews (Stein 2006).

During WWI, the government nationalized railroads and instituted price controls on railroad ties and other lumber. In addition to wartime restrictions, forest management plans were written and implemented in the 1920s. As a result of a 1923 plan, based on an earlier 1910 plan, timber harvesting guidelines were finally put in place. Under these requirements, the forest was divided into blocks, and logging units and restrictions were applied. Forest replenishment (replanting) was considered for the first time. Sheep were to be limited, and an increase in fire protection was instituted in order to allow the seedlings to grow. By 1927, the Saginaw and Manistee Lumber Company had logged their own lands to the point that the only trees available to them were on federal lands. In 1938, the Forest Service began to limit timber harvesting to improve forest health. In 1941, the Arizona Lumber and Timber Company ceased its timber operations and leased its entire works to the Saginaw and Manistee Lumber Company, which supplied ties to the Prescott & Phoenix Railroad (Stein 2006).

Timbering north of the Grand Canyon began in the late 1800s. The earliest sawmill on the Kaibab Plateau was set up at Levi Stewart's ranch at Big Springs in 1871 and later moved to Castle Springs; but by 1878, the site had been abandoned (Altschul and Fairley 1989). A second mill was constructed at Jacob's Lake in the late 1870s or early 1880s and was the only mill operating within the Forest Service boundaries in 1910 (Lang and Stewart 1910). The Jacob's Lake mill burned in 1911 or 1912, and a new mill was built in LeFevre Canyon (Altschul and Fairley 1989). These early operations were steam driven, with crews of six to eight men. A crew would log in the spring until enough logs were stockpiled, and then that same crew would work the sawmill. When the timber was depleted, the entire operation was moved to a new location (Altschul and Fairley 1989).

The area that is now the North Kaibab Ranger District was originally withdrawn from the public domain in 1893 as part of the Grand Canyon Forest Reserve and transferred to the Forest Service in 1907 (Anderson 2000). The Forest Service conducted an inventory of the timber resources on the Kaibab Plateau in spring 1910 and determined that there were approximately 1,362,130 board feet of marketable lumber in the forest. However, the lack of adequate transportation, primarily a railroad, rendered large-scale timbering infeasible (Lang and Stewart 1910). The Utah Southern Company expressed an interest in constructing a railroad from Utah to the North Rim of the Grand Canyon in the early 1900s, but the plans fell through (Altschul and Fairley 1989).

Logging in the North Kaibab Ranger District remained a small, localized enterprise until the 1940s, when the WWII war effort and post-war economic boom created an increased demand for lumber. By 1945, the Whiting Brothers company from St. Johns, Arizona, operated a sawmill at Jacob's Lake and in House Rock Valley and eventually added a planing mill. In the early 1950s, the Forest Service increased the annual timber harvest in the North Kaibab Ranger District to 25,000,000 board feet and bid out a 25-year contract, which was known as the Big Saddle Timber Sale. The winning contractor was required to have enough capital to construct a complete single band sawmill with a daily capacity of 20,000 board feet, a fleet of logging trucks and tractors, and the means for installing logging camps and roads in the vicinity of the Big Spring Ranger Station. The Whiting Brothers won the contract, ensuring the company a monopoly on the Kaibab Plateau for 25 years (Altschul and Fairley 1989). Presently, logging is used as a forest management tool within the North Kaibab Ranger District.

I.4.13 Ranching and Grazing

Ranching in the West can be divided into two general periods (Sayre 1999). These periods are 1) open-range grazing; and 2) government regulated and fenced ranching. The open-range grazing period had become well established in Arizona by the late 1870s after the introduction of cattle on the range and continued until the Taylor Grazing Act of 1934. Cattle ranchers could obtain land through the 1862 Homestead Act, which provided 160-acre parcels; the Timber and Culture Act of 1873, which increased the amount of land if the owner planted 40 acres of trees over time; and the Desert Land Act of 1877, which expanded the acreage to 640 because of the lack of water in the West. The land had to be irrigated, and a small per-acre fee was assessed.

Along with these homesteading acts, land was claimed simply by its use. Livestock grazing in the region has evolved and changed considerably since it began in the 1860s. At the turn of the century, large herds of livestock grazed on unreserved public domain in uncontrolled open range. Eventually, the range was stocked beyond its capacity, causing changes in plant, soil, and water relationships. Protective vegetative cover was reduced, and more runoff brought erosion, rills, and gullies.

In response to these problems, livestock grazing reform began with the passage of the Taylor Grazing Act in 1934. This legislation was intended to prevent overgrazing and soil deterioration; to provide for the orderly use of the public lands; and to stabilize the livestock industry, which depended on the public range.

Before the passage of the Taylor Grazing Act, many different interests had pushed for either local or national control. Many in the federal government supported national control over these lands, viewing them as a public asset. This position was strengthened with passage of the Emergency Conservation Work Act, also in 1934, because administrators of this federal work program did not want to invest time, money, and manpower into lands not under federal control (Paige 1985; Seymour 1995).

Because it changed the way the government managed federal land, the Taylor Grazing Act of 1934 was probably the most significant federal legislation the West has seen to date. For one, it essentially ended the Homestead Act, and for the first time, the federal government asserted authority over the "public domain." In the years leading up to this legislation, state and federal interests debated how to use and control western lands. This legislation ended that debate. One result of this legislation was that livestock associations were encouraged to organize and seek local oversight.

Ranching and Grazing on the Arizona Strip

Euro-American exploration of the Arizona Strip began in earnest with Mormon missionary expeditions in 1858–1859, which were led by Paiute guides. Missionary Jacob Hamblin remained with the Paiute through the 1860s (Spangler 2007). Hamblin and other settlers began staking claims to springs and establishing ranches in the western portion of the Arizona Strip and in the present North Kaibab Ranger District in the early 1860s. In 1871, at the urging of Hamblin, John D. Lee established a ranch and ferry crossing in Marble Canyon. The ranch became known as the Lonely Dell and the ferry as Lee's Ferry. The ferry was operated by Lee's wife Emma until 1874. She was followed by Warren Johnson, who purchased the ferry and operated it until 1894. The ferry was the only means of transporting cattle and Mormon settlers to the North Rim and the Kaibab Plateau (Altschul and Fairley 1989; Spangler 2007).

John D. Lee established ranches at House Rock Springs and Jacob's Pools, named for Jacob Hamblin, in the House Rock Valley in 1872. Mormon settlement continued to grow throughout the 1870s, and in 1874 the Church of Latter-Day Saints (LDS Church) began to experiment with communalism. The United Order of Orderville (OUO) was the most successful of the communalism ventures, established in an effort to overcome the economic impact of the Panic of 1873. All possessions of the OUO were held in common among participating members, with the exception of houses and house lots. Labor was organized for the good of the community, and products were shared equally (Altschul and Fairley 1989). By 1878, the OUO had acquired the water rights to House Rock, Kane, Castle, and Elk Springs and Jacob's Pools for watering cattle and sheep. Another large-scale venture, known as VT, was operating simultaneously out of Big Springs Ranch in what is now the North Kaibab Ranger District. OUO cattle and sheep grazed the northern lands of the Arizona Strip, and VT livestock grazed the southern lands of House Rock Valley and the Kaibab Plateau (Altschul and Fairley 1989; Spangler 2007).

In 1887–1888, the OUO and VT cattle companies dissolved, with livestock holdings distributed to shareholders. John W. Young, son of Brigham Young, formed the Kaibab Cattle Company with his share of both companies and obtained the rights to House Rock Valley and DeMotte Park (VT Ranch) on the

North Kaibab Ranger District. The Canaan Cattle Company also operated out of House Rock Ranch as a quasi-private enterprise made up of other shareholders of the defunct OUO and VT companies (Altschul and Fairley 1989).

In the late 1800s, while on a mission in England, John W. Young convinced “Buffalo” Bill Cody to act as a tour guide for a handful of English aristocrats at Young’s ranch. The group arrived in 1891 and stayed at Kane Ranch while touring the Kaibab Plateau and the North Rim of the Grand Canyon. The aristocrats deemed the area too remote and inaccessible to be profitable, and the failure of the venture encouraged Young to relinquish his ownership claims on the Kaibab Plateau to the government for the establishment of the Grand Canyon Forest Reserve in 1893 (Spangler 2007).

In 1895, the Canaan Cattle Company and House Rock Ranch were sold to Benjamin F. Saunders, a prominent rancher on the west side of the Arizona Strip. In 1899, Saunders obtained the Kane Ranch and became known as “the Bar Z Outfit.” Disputes with neighboring ranchers such as James Emmett led to the construction of a drift fence along the eastern edge of Saunders’ properties in 1906; overgrazing of areas west of House Rock Valley by Saunders’ cattle prompted the Forest Service to construct a drift fence along the western edge of his properties in 1909. In 1907, the Grand Canyon Cattle Company purchased Saunders’ holdings, and in 1909, they purchased Lee’s Ferry from the LDS Church in an effort to thwart James Emmett and secure access to Flagstaff for the sale and transportation of livestock (Altschul and Fairley 1989; Spangler 2007). The ferry was then sold to Coconino County the following year (Altschul and Fairley 1989). The company operated large-scale cattle ranching on the Arizona Strip until at least 1924 and hosted Theodore Roosevelt and his sons at House Rock Ranch during a mountain lion hunt on the North Rim of the Grand Canyon in 1913 (Spangler 2007).

Henry S. Stephenson and Genaro Fourzan purchased the Grand Canyon Cattle Company in 1930. By 1933, Fourzan was no longer listed as a partner, which left Stephenson as the largest landowner in the eastern Arizona Strip, with water rights to the whole of House Rock Valley (Spangler 2007). The Taylor Grazing Act of 1934 dealt a harsh blow to large-scale ranching, and in 1939, as the result of a divorce settlement, Stephenson began selling off his properties to neighboring ranchers. The last of his holdings, including all rights to House Rock Valley, were sold in 1945 to Royal Woolley (Spangler 2007).

The Grand Canyon Trust and the Conservation Fund purchased Kane Ranch and Two-Mile Ranch in House Rock Valley in 2005 with the intention of rehabilitating the ecosystem from years of overgrazing and developing conservation-based, sustainable land management practices (Grand Canyon Trust 2009).

Grazing in Arizona’s Forests

According to Putt (1991), grazing was the Kaibab National Forest’s first industry. Cattlemen began to bring livestock into the area in the 1850s and 1860s to support the early military excursions into the region. Beale’s Wagon Road was used by sheep herders to push herds from New Mexico to California at this time. Once the Civil War began, livestock was also herded to military bases in California, Arizona, and New Mexico.

Because of poor range conditions and overcrowding in California in the 1870s, many ranchers brought their herds east. Unlike in California, homesteaders had not created fences in Arizona, and open range was available to graze on. On the Kaibab National Forest, the first permanent ranches were established around the Bill Williams Mountain area in 1876, but it was construction of the railroad in 1882–1883 that increased settlement of the area. The area was particularly suited to sheep, and by 1884 many herds had been moved there. It did not take long before there were more livestock than there was forage for them. By 1890, conflict had developed with Euro-American ranchers, who were using Havasupai and Hualapai traditional lands.

Drought and overgrazing had caused the condition of the forest to deteriorate, and ranchers knew that something had to be done. In 1898, the San Francisco Forest Reserve was established. At that time, the reserve consisted of even-numbered sections, with the odd-numbered ones being private lands. Almost immediately, the federal government realized that managing these 1,500 sections of 1 square mile of forest would be almost impossible. Federal law allowed cattle grazing but not sheep grazing. Therefore, the government embarked on an ambitious plan to trade out the private lands into federal control. Property owners would have the opportunity of having equal lands elsewhere. The largest landowners were the AT&SFRR, the Perrin and Baker families, the Aztec Land and Cattle Company, and the Saginaw and Manistee Lumber Company.

A study of range conditions conducted by Gifford Pinchot in 1900 resulted in the finding that livestock grazing, including sheep, was compatible with forest management goals. Pinchot did, however, recommend that the Forest Service restrict the size of the herds. The government instituted several measures, such as increased grazing fees and fencing, but they were not strictly enforced. Permits were becoming harder to get, especially as officials cut the number of livestock permitted to graze on the forest. As WWI began, the increased need for meat caused prices to escalate, resulting in more permit applications' being submitted.

Into 1925, the range continued to suffer. Permit costs continued to rise as numbers of livestock allowed were dropping. Fees were to be tripled from those instituted in 1906. Fencing was to be required. Because of the demand for livestock and the poor economy, these measures were not enforced. The only change was the reduction in livestock numbers. With this one change, however, only the largest cattle operation had survived into the 1920s. Ten years later, with the enactment of the Taylor Grazing Act, federal lands administered by the Department of the Interior were subject to even greater control over grazing practices to improve the condition of the rangelands.

Basque sheepherders experiencing crowded ranges and increased expenses in California took advantage of the open spaces in the Great Basin and interior Arizona that had been approved for sheep grazing. Basque immigration, with the express intent of sheepherding, was highest from 1900–1930 (Egurrola 1998). Basque sheepherders had a unique tradition of carving dendroglyphs on aspen trees throughout their grazing areas, many of which are present in the Kaibab National Forest. The glyphs consisted of names, dates, pictures and symbols, and occasionally poetry (Mallea-Olaetxe 1992). While many of the carvings were simply the doodles of lonely sheepherders, others served specific purposes. Carving one's name in a tree was a way of staking a grazing claim, and symbols and messages served as a way to communicate with other sheepherders in the region. One such glyph in Nevada commemorated the meeting of two herders from separate Basque villages who met in the forest to celebrate the running of the bulls in Pamplona (Mallea-Olaetxe 1992). The carvings of specific sheepherders are so prolific that their migrations can be traced from season to season and year to year. Timbering in the forest, combined with the relatively short lifespan of aspen trees, has led to increased efforts in the recording of dendroglyphs within national forests (Mallea-Olaetxe 1992).

I.4.14 Homesteading and Farming

The 1862 Homestead Act allowed the head of a family to file on a parcel of 160 acres after living on it for five years. The land had to be surveyed first. Many settlers moved onto public lands, built a house, and plowed a field. They could then file a claim for the land. With enactment of the Creation Act in 1891, people who had not filed could no longer do so, and some lost their property. In 1902, the government gave these settlers a final chance to fill out the papers. The deadline for the act, which gave "relief for bona fide settlers on forest lands," was two years.

The 1862 Homestead Act and the Forest Homestead Act of 1906 encouraged homesteading in the West. However, forest lands in the project area were withdrawn from the public domain in 1893 with the creation of the Grand Canyon Forest Reserve and as such could not be homesteaded.

Homesteading on the Arizona Strip was limited by the scarce water resources, which were mainly controlled by ranchers beginning in the 1870s (see above). The majority of homesteading claims in the Arizona Strip were created by Mormon families in a string of farmsteads along the base of the Vermilion Cliffs and the western flank of the Kaibab Plateau. The earliest farming communities on the Arizona Strip were Beaver Dams (1870s), Fredonia (1885), and Short Creek (Colorado City, ca. 1909) (Altschul and Fairley 1989).

The Dry Farming Act of 1909 encouraged homesteading claims further south into the strip, allowing homestead claims of 320 acres in areas potentially suitable for farming without irrigation. By the 1920s, homesteading communities in the western strip included Tuweep east of Mt. Trumbull, Little Tank in the Main Street Valley, Wolf Hole, and Bundyville west of the Hurricane Cliffs. In 1913, homesteaders began staking claims in the rangelands surrounding the Bar Z Canebeds Ranch and the southern portion of House Rock Valley. Increased competition for range lands and Forest Service grazing fees eventually led the Grand Canyon Cattle Company (Bar Z) to leave House Rock Valley (Altschul and Fairley 1989).

Beginning in 1927, there were several years of drought, which, coupled with the drop in prices during the Great Depression, caused many farmers to lose their land because they could not pay their taxes. Homesteads that were sold were bought by local ranchers, although subsistence farming was still popular because it fed families. With the passing of the Taylor Grazing Act of 1934, all vacant, unreserved, and inappropriate public lands were withdrawn from settlement. This was the end of new homesteads and slowly became the end of much of the farming in the region.

I.4.15 Mining

As early as 1650, the Spanish may have mined silver near Red Butte (Putt 1991). More widespread prospecting did not begin, however, until the 1860s, when Sam Ball of the Miller Party hunted north of Bill Williams Mountain. Discoveries of copper on the North Rim motivated miners to prospect on the South Rim, as well. Small discoveries in the 1880s of copper ore were made by the Cameron brothers, Ralph and Niles, and their partner, Pete Berry. These three filed numerous claims around the Grand Canyon (Billingsley et al. 1997).

Starting in 1866 with Revised Statutes 2318 (better known as the Lode Law of 1866), "the mineral lands of the public domain, both surveyed and unsurveyed, were opened to the free and open exploration and occupation by all US citizens of the United States." A similar second law, the Placer Act of 1870, was then passed by Congress. Then in 1872, President Ulysses S. Grant signed a mining law intended to promote the settlement of publicly owned lands in the West. This third mining law combined the Lode Law of 1866 and the Placer Act of 1870 and promoted development by allowing mining interests to take valuable hardrock minerals, including gold, silver, and uranium, from public lands.

During Powell's expedition in 1872 (see above), two of his packers discovered gold in the sand at the mouth of Kanab Creek. A rush of miners flooded the area, only to discover that the gold was too fine to be exploited profitably (Billingsley et al. 1997). Copper, however, was abundant and lucrative.

The Bentley Mining District was formed in the western portion of the Arizona Strip ca. 1873 and produced at least four successful mining ventures. Mining on the Kaibab Plateau picked up with a boom in the 1890s, when the Warm Springs District was formed. The earliest ventures at Warm Springs, led by the Petosky Mining Company and the Coconino Copper Company, failed within a few years as a result of the lack of transportation and other resources (Altschul and Fairley 1989).

An increase in copper prices during WWI renewed interest in copper on the Kaibab Plateau, prompting John Mackin to stake several mineral claims in 1916. In 1928, the St. Anthony Copper Company was organized, began mining the Mackin claims, and constructed a railroad to the former Coconino Copper Company site at Ryan. Another spike in copper prices during WWII led to the formation of the Apex Mining Company, which took over the Mackin deposits in 1943 (Altschul and Fairley 1989).

Hack's Canyon in the western Plateau was claimed in the 1890s and mined by hand until the early twentieth century. The Canyon Copper Company constructed a tramway to the bottom of the canyon during WWI. The company produced copper ore until 1946 and was reorganized as the Hacks Mining Company in 1951 after the discovery of uranium in the ore. The Hacks Mining Company leased out their mining claims, which resulted in little production, and the mine sat idle from 1954–1957. More leases and exploration from 1957–1964 yielded little, and the mine sat idle again until 1977. Energy Fuels Nuclear leased and eventually purchased the mine and produced uranium from three sites in the canyon until 1987, followed by two years of environmental cleanup (Billingsley et al. 1997).

In 1890, Fred Nellis found a surface outcrop 45 miles north of Williams that contained copper. Calling it the Anita Mine, he teamed up with others in 1897 to build a railroad to haul a steam tractor to the site and constructed a smelter in Williams. The Anita Mine went bankrupt the following year, and the rail line was purchased by the Santa Fe & Grand Canyon Railroad. As with most railroad ventures, numerous financing and related management changes occurred until the AT&SFRR took over and finished the line in 1901. Once the track was extended from the AT&SFRR line through Williams north to the South Rim, the Grand Canyon Railway began transporting tourists to the Grand Canyon (Billingsley et al. 1997; Stein 2006).

In 1902, William Lockridge bought up the Anita Mine's claims. He hauled the smelter from Williams to the mine and was convinced that a new chemical method would be profitable. He and his men sunk shafts more than 500 feet below surface but had little luck. The mine mostly closed for a second time in 1905. In 1907, Lockridge sent six ore cars to the Verde Valley Smelter, averaging $1,200 per car. By 1910, the mine had been closed for good (Billingsley et al. 1997; Stein 2006).

In 1893, Daniel Hogan filed a claim on the South Rim of the Grand Canyon. After serving as a Rough Rider under Teddy Roosevelt in the Spanish-American War, Hogan began mining his "Orphan Mine" in 1903. Uranium was discovered in the deposits and mined by the Golden Crown Mining Company from the early 1950s through 1969. In 1953, the Mining Company purchased 10 acres in Tusayan to house mine workers in a U-shaped campsite (Coconino County 1995).

Other mining endeavors south of the Grand Canyon included cinders for road construction starting in 1920 and continuing into the 1930s; flagstone for building material mined near Ash Fork; and limestone from the same area, used for cement. Cinder and flagstone quarries are still in operation in the area (Billingsley et al. 1997; Stein 2006).

I.4.16 Tourism and Recreation

It was quickly learned that more money could be made by bringing visitors to the Canyon than by mining. There were three factors that influenced tourism and recreation in the region: the presence of the Grand Canyon, the development of forest transportation, and the instability of other local industries, such as mining, lumber, and ranching. Although tourism did not become a significant forest use until the 1920s, it did have roots in much earlier years. Early on, recreational activities were limited, travel was difficult, and accommodations were very rustic. The draw of the Canyon compensated for the rough facilities.

Tourism enterprises on the Arizona Strip began with John W. Young, son of Brigham Young, when he started his cattle ranches in House Rock Valley. As noted above, Young enticed Buffalo Bill Cody to guide a group of English aristocrats through the area in 1891, but the isolation of the Arizona Strip from transportation thoroughfares rendered tourism infeasible until well into the twentieth century.

A pattern of bridle paths and wagon ruts interwoven through the Arizona Strip between the ranches of House Rock Valley and the Kaibab Plateau, west to the mines of Hacks Canyon and St. George, and north to Fredonia were the only "roads" in the Arizona Strip in the early 1900s; none reached the rim of the Canyon until 1917–1918. Funds were appropriated in the 1920s for improved roads, and construction began in the 1930s on a system that remains in place today (Anderson 2000).

South of the Grand Canyon was a different picture, with tourism developing in the late 1800s. The best-known stage line to cross the Kaibab National Forest was the Flagstaff–Grand Canyon Company. From 1892 to 1901, for $20.00, the stage carried passengers for approximately 70 miles, from the trail depot to the South Rim of the Grand Canyon. Starting in Flagstaff, it headed northwest to Grandview Point. A stage station was established at Moqui Tanks, which was at the approximate halfway point of the route. No more than a small cabin, it did have water, which had to be hauled in. In 1883, Pete Berry (see above) built the Grandview Hotel at the end of the line (Putt 1991).

Two brothers, William and Phillip Hull, brought tourists to the Grand Canyon for the first time in 1884 via a wagon road they had built from Flagstaff to their sheep ranch. In 1885, their new partner, John Hance, built a cabin on the South Rim to house the guests the Hulls brought from Flagstaff by stagecoach. Hance operated asbestos mines at the bottom of the Canyon and led tourists down his mine trail to the river. Also in 1885, William Bass built two roads: one from Williams, the other from Ash Fork to the South Rim. In addition to mining asbestos claims, Bass operated a 12-room hotel at his camp and provided the only rim-to-rim trail in the Canyon (Anderson 2000; Billingsley et al. 1997).

Ralph Cameron was probably the biggest entrepreneur, laying claim to many of the better locations on the South Rim. Along with his brother, partner Pete Berry, and others, Cameron improved a Havasupai trail (now the Bright Angel Trail) in 1891. Berry obtained a franchise to operate the "Cameron Trail" as a toll road that same year (Billingsley et al. 1997).

By 1901, the Santa Fe and Grand Canyon Railroad had been completed from Williams to the Anita Mine camp. The AT&SFRR purchased the line from the owners of the mine and completed the tracks to the South Rim. From 1901–1968, the Grand Canyon Railway shuttled tourists between Williams and the South Rim before enduring a nearly 30-year hiatus in service. In 1902, Bass managed to get a flag stop on the railroad for his hotel and tour business, which operated until 1923. The AT&SFRR and the Fred Harvey Company constructed the El Tovar Hotel on the South Rim in 1905, and shortly thereafter, Daniel Hogan completed the Grand Canyon Trading Post (now the Grand Canyon Inn) near his Orphan Mine (Billingsley et al. 1997).

Cameron and his partners completed the Cameron Hotel at the head of the Cameron Trail in 1903, and Cameron began to file mining claims at strategic points along the trail. In one year he obtained 39 mining claims, including the area at the head of the trail (Cape Horn), the only water source along the trail (Indian Garden), and the section of trail along the Colorado River. Berry's franchise for operating the trail as a toll road expired in 1906, and the trail reverted to Coconino County. As a member of the County Board of Supervisors, Cameron convinced the County to allow his friend Landes L. Ferrall operate the trail. The AT&SFRR filed for control of the trail; however, through his political influence, Cameron subverted the claim. In 1909, the General Land Office invalidated Cameron's mining claims on the grounds that they were devoid of minable ore; at the same time, the AT&SFRR began a plan for its own trail and development that would bypass Cameron's trail (Anderson 2000). In 1910, Cameron began selling off his claims to investors from New York and Philadelphia, selling the last of them to the Santa Fe Land Company in 1916 (Billingsley et al. 1997). After Grand Canyon National Park was established in 1919, Cameron became a U.S. Senator and retained control of the trail despite legal action from the Forest

Service against his claims (Anderson 2000). In 1923, he was sued once again, this time for not removing his structures and employees from the Cape Horn and Indian Garden areas. After losing his senate seat in 1926, Cameron gave up his hold on the trail, and in 1928 the title for the "Cameron Trail" was transferred to the NPS (Billingsley et al. 1997).

The area was put under Forest Service control in 1905. That same year, rangers began to use the abandoned Hull cabin, making it the Grand Canyon's first administrative office. One of first tasks was to deal with overgrazing and encounters between tourists and cattle along the rim. Fencing was required as a condition of a grazing permit for the first time. Trails were being constructed and improved. By 1908, when President Theodore Roosevelt established Grand Canyon National Monument, a shanty town had developed along the rim. The new legislation gave the Forest Service the ability to plan and restrict growth. The first forest management plan was finished in 1909 (Anderson 2000).

The Fred Harvey Company, a contractor with the AT&SFRR, constructed many service buildings between 1902 and 1919 that are still in use today, such as the El Tovar Hotel, Hopi House, mule barns, Fred Harvey Garage, Lookout Studio, and Hermit's Rest. As a for-profit company, however, the Railroad and the Harvey Company did little to provide for the Forest Service employees or to keep up the roads. The lack of accommodations for visitors who arrived by car, the lack of organization of staff quarters, the rampant grazing and fuel-wood cutting occurring in the forest, and a cultural shift emphasizing the importance of protecting natural resources led to the creation of Grand Canyon National Park in 1919. The Forest Service retained control of the forested areas north and south of the Park, and the Park was placed under the control of the fledgling NPS (Anderson 2000).

Before WWI, tourism was not the focus of business in the regions around the Grand Canyon in part because of the success of ranching and timber industries (Putt 1991). Local residents appeared to be more focused on trying to develop the Kaibab National Forest's mineral resources. Following WWI, however, with the ensuing economic slump and the lack of a viable minerals industry, local residents started looking for other opportunities. With the spread of the automobile across the nation, more and more people slowly began to travel and visit places like the Grand Canyon and its surrounding forests.

With the growing popularity of the "road trip" and the new east-west continental and Verde Valley roads, support facilities such as gas stations, motels, and restaurants began to spring up. Unfortunately, there were few campgrounds, picnic facilities, hiking trails, and fishing locations. Ad hoc camping locations with multiple fire rings and trash scattered all around became a big problem along the road. To address some of these issues, the Forest Service and local commerce groups teamed up to develop scenic resources and centralized recreation sites. Dispersed camps were too difficult to manage and created health and fire hazards. In response to the increasing need, the Regional Forester announced in 1921 that each national forest was to assist the local community to locate and develop campgrounds as well as locations for summer cottages and hotels (Baker et al. 1988:127–129).

In 1933, a National Plan for American Forestry, better known as the Copeland Report, was issued. This document was the result of a congressional investigation of forestry for the purpose of outlining a coordinated plan that would "insure all of the economic and social benefits which can and should be derived from productive forests by fully utilizing the forest land" (Putt 1991). The investigation was called for by Senator Royal S. Copeland of New York in Senate Resolution 175 (72nd Congress, 1st Session, 1932). This report marked a change in how the forests were administered, from simple custodial oversight to one of active resource management. Along with conservation and protection measures, Copeland recommended increased planning for recreational use (Putt 1991).

As a result of the Copeland Report, the Regional Forester reported in 1934 that recreational planning and development began to take precedence over all other Southwest Region projects (Baker et al. 1988:130). In the 1930s, as visitation by the public doubled, funding for such projects began to increase dramatically.

Concurrently, the CCC began to station large crews in the region, ready to take on projects. Ultimately, with their many improvement projects, the CCC helped drive the tourist industry in Arizona. Tourism boomed after WWII in part because of the new roads, trails, campgrounds, and facilities that the CCC had provided. The CCC improved Arizona's national and state parks, national forests, and recreation areas. They built ranger stations and support facilities. They expanded transportation and communication infrastructure, which helped to attract both visitors and new residents. Just before WWII, tourism grew to become the No. 3 most important industry, behind mining and railroads. Today, with the early help of the CCC, tourism has grown to the No. 1 position in Arizona (Booth 2002).

I.4.17 Civilian Conservation Corps

The problem in the West with soil erosion and overgrazing prompted the federal government to institute a soil conservation program in the United States (Seymour 1995). At least 25% of all youths between the age of 15 and 24 were unemployed, and another quarter of the country was underemployed during the Great Depression. The CCC employed thousands of workers in dozens of camps to rectify the soil, vegetation, and erosion problems. Down from an original 8 million acres of old-growth forest, by the 1930s, less than 1 million acres remained. This and the combination of overgrazing and drought created massive soil erosion problems.

CCC camps were located throughout Arizona. Workers built roads, improved springs, constructed earthen tanks and soil erosion features, built fences, and reseeded soils. They built new roads and bridges for access into the nation's forests. Even before Roosevelt became President, a few subsistence camps for the unemployed were operating in California and Washington, and relief work had begun in a limited fashion in the nation's forests. The men were clothed and fed by the various states and worked for the federal government.

As the economic crisis continued to worsen in the beginning of 1933, President Franklin D. Roosevelt laid out a plan to employ 500,000 men in a variety of conservation tasks. Under the authority of the Emergency Employment Act of March 31, 1933, President Roosevelt established the Emergency Conservation Work (ECW) by Executive Order 6101 on April 5, 1933. Then, the CCC was created by an act of Congress on June 28, 1937. The ECW had been incorrectly referred to as the CCC and by this act, the ECW programs were transferred to the CCC and the popular name legally adopted. The CCC was already a functioning program; therefore, the president gave the effective date of the act as March 31, 1933.

The purpose of the CCC was to provide employment and technical training to the unemployed, a limited number of veterans, and American Indians. Terms of enrollment were for six months, and at the end of six months, they had an option to re-enlist for another period, for a maximum of two periods. This was later changed to an unlimited number of terms.

The enrollee was paid $30 a month, $25 of which was sent back home. The $5 was for the enrollee to spend in the camp store or during their recreational visits to the local town. In many cases, this was the only income that families had. Room, board, clothing, tools, and medical facilities were provided by the government. Table I-1 shows the period listings and number of camps occupied in Arizona for the duration of the CCC in this state (Enrollment Period Listings, National Archives). Table I-2 provides the abbreviations for the types of camps occupied.

The first camp in the country was a 13-acre camp located in the George Washington National Forest, Virginia. It was designated F1 and opened on April 17, 1933. It finally closed on May 25, 1942 (Cohen 1993). The first camp in Arizona was A-1 at Fort Huachuca. Two hundred fifteen men were sent there on May 9, 1933, from Tucson, Ajo, Bisbee, Douglas, and Nogales (Booth 1991:32).

There were four kinds of enrollees nationally by the end of 1933. These were 250,000 junior enrollees between the ages of 17 and 25; 25,000 veterans; 25,000 Local Experienced Men serving as project leaders in the junior camps; and 10,000 American Indians enrolled in the Indian Division. A junior enrollee had to be single and from a family on relief, pass a physical examination, and enlist for a minimum of 6 months (Booth 1991; Cohen 1993; Government Printing Office 1939). Men came from blue collar, middle-class, and rural families in Arizona. In Graham County, many were Hispanic (Booth 1991:29–30). Although there were no women's camps in Arizona, several camps in New Hampshire and New York enlisted women (Cohen 1993:8).

In response to the worsening drought in 1934, Roosevelt increased enrollment nationally. He ordered 50,000 junior and 5,000 veteran enrollees from urban areas to be added. He wanted a total of 600,000 people enlisted. Enrollment peaked, however, at 502,000 people nationally in September 1935 (Cohen 1993:24). From this date on, enrollment decreased until it was below 400,000 in 1937. Despite the drop, on April 2, 1937, the President proposed that the CCC be made a permanent agency. Although this did not occur, the program was extended through 1940.

Beyond changing the name to the CCC, the 1937 act increased authority by dropping the relief requirement for enrollment and added education and training opportunities. It also, for the first time, set a maximum number of participants at 315,000. In June 1939, an extension was granted through June 30, 1943.

Table I-1. Enrollment Periods in Arizona (Enrollment Period Listings, National Archives, Washington)

Period	Date	Number of Camps Occupied
1	1933	23
2	winter 1933–1934	30
3	1934	19
4	winter 1934–1935	27
5	1935	59
6	winter 1935–1936	49
7	1936	?
8	winter 1936–1937	37
9	1937	?
10	winter 1937–1938	30
11	1938	26
12	winter 1938–1939	?
13	1939	27
14	winter 1939–1940	28
15	1940	27
16	winter 1940–1941	27
17	1941	17
18	winter 1941–1942	15
19	1942	5

Table I-2. Types of Camps in Arizona and Their Abbreviations

Abbreviation	Type of Camp
F	National Forest
NP	National Parks
SP	State Parks
NM	National Monuments
SES	Soil Erosion Service
SCS	Soil Conservation Service
BR	Bureau of Reclamation
DG	Division of Grazing
G	Grazing Service
A	Army
CP	County Park
MA	Metropolitan Area
FWS	Fish and Wildlife Service

In the CCC's nine-year history between 1933 and 1942, there were more than 120 camps in Arizona. In and adjacent to the proposed withdrawal areas, there were six camps in what is now Grand Canyon National Park, three near Fredonia, and 11 in the area around Flagstaff/Williams. There were also several more in the St. George area. The CCC "projects fell into four intertwined categories: 1) resource protection; 2) resource development; 3) rural infrastructure construction; and 4) recreational development" (Booth 1991:25).

Several camps were located near or within the withdrawal area (Table I-3). The timber industry in northern Arizona enlisted the CCC to help with forest fires. They also needed help eradicating trees with twig blight on the Kaibab National Forest. Several camps worked on removing trees with this disease (Booth 1991:69). The CCC also implemented the forest plan that had been written years before but that because of lack of funding and manpower had not been implemented. The CCC reseeded thousands of acres with ponderosa seedlings.

Camps at the Grand Canyon helped with construction at the village. They also built trails for improved public access. By 1935, Grand Canyon had four camps completing projects such as controlling insects, constructing roads, fighting twig blight, running a trans-canyon telephone line, and constructing a pumping system to bring water from Indian Gardens to the South Rim (Anderson 2000:27).

In May 1933, Camp NP-1 opened at the bottom of the canyon in order to begin construction on the Colorado River Trail (Purvis 1989, 2002). Camp NP-2 was opened at the east end of Juniper Hill. By July 1933, its 200 men had arrived from all over Arizona. The next year, NP-4 was opened, and the CCC was put to work building fences to keep the cattle out of the Park. A partial list of projects completed by the CCC in and near the village can be found in the Grand Canyon Village Cultural Landscape document (JMA, Inc. 2004).

Table I-3. CCC Camps in and near the Proposed Withdrawal Area

Camp No.	Company No.	Camp Name	Enrollment Period (6-month terms)	Date Opened	Comments
CP-2	1837	Hualapai	15, 16	5/19/1940	
DG-44	2557	Fredonia	6	10/20/1935	Not in Enrollment Period Listings
DG-45	2558	St. George, Utah	6	10/27/1935	Pipe Spring, 160 miles south of Maysville—not in Enrollment Period Listings
G-135	1820	Short Creek	15, 16, 17	4/6/1940	
G-170	847	Fredonia	15, 16, 17, 18	8/10/1940	Antelope Springs, 399 miles northwest of Phoenix
G-173	1814	Bull Rush	15, 16, 17, 18	8/10/1940	436 miles northwest of Phoenix
F-27	851	Bellemont	1, 2	5/26/1933	
F-28	848	Williams	1	5/26/1933	
F-28	1826	Williams	3	4/30/1934	
F-28	3348	Bill Williams	15, 16	5/5/1940	
F-28	1838	J.D. Dam	5	5/16/1935	
F-28	3348	J.D. Dam	13, 15	5/14/1939	J.D. Dam, 9 miles south of Williams
F-28	2833	J.D. Dam	7	4/30/1936	J.D. Dam, 9 miles south of Williams
F-29	1823	Williams	3	4/30/1934	
F-38	1838	Williams	5	5/16/1935	J.D. Dam, 9 miles south of Williams
F-5	311	Flagstaff	13	5/20/1939	5 miles north of Flagstaff
F-5	821	Flagstaff	1, 3	5/28/1933	5 miles north of Flagstaff
F-6	863	Flagstaff	1, 5, 7	6/2/1933	
F-75	863	Columbine	11	5/22/1938	
F-75	822	Pivot Rock	19	5/21/1942	
F-75	863	Pivot Rock	9, 11, 13, 15, 16, 17, 18	5/27/1939	
F-75	2855	Pivot Rock	9, 11	5/29/1937	
F-80	311	Flagstaff	15, 17	6/3/1940	
F-80	822	Flagstaff	17	6/24/1941	3.5 miles north of Flagstaff
F-80	842	Flagstaff	18	6/24/1941	

After 1935, the CCC program went into decline. As the economy began to recover in the mid- to late 1930s, the need, or at least public opinion regarding the need, became less. In 1937, Roosevelt tried to make the CCC a permanent agency; however, he was unsuccessful. In 1940, the CCC cut the number of camps from 40 to 22, and by 1941, there were only 15 operating in Arizona. After the start of U.S. involvement in WWII, the CCC was used for wartime protection of local facilities. Some camps were used to renovate or build military facilities. The Army started moving barracks to military reservations to house troops and even Japanese prisoners in California.

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Appendix J

RECREATION OPPORTUNITY SPECTRUM

CRITERIA FOR RECREATION CLASSIFICATION (CHAPTER 3) AND RECREATION IMPACTS (CHAPTER 4)

The following tables describe the recreation setting character conditions required to produce recreation opportunities and facilitate the attainment of both recreation experiences and beneficial outcomes.
The Recreation Opportunity Spectrum (ROS) offers a framework for understanding the relationships and interactions the public may experience with a particular area of public land. ROS settings are used by the Bureau of Land Management (BLM) and U.S. Forest Service. The ROS setting framework was developed by the U.S. Department of Agriculture in *Recreation Opportunity Spectrum: A Framework for Planning, Management, and Research* (General Technical Report PNW-98, December 1979).

This characterization of settings is used for both describing existing setting character (Chapter 3) and describing impacts to recreation (Chapter 4). Indicators and standards for monitoring setting conditions would be derived and/or developed from the (a) through (i) components in Table J-1.

Table J-1. Characterization of Settings

Primitive	Semi-primitive Non-motorized	Semi-primitive Motorized	Roaded Natural	Rural	Urban
Physical – Resources and Facilities: Character of the Natural Landscape					
a. Remoteness					
>3 miles from any road	>0.5 mile from any kind of road, but not as far as 3 miles, and no road is in sight.	On or near 4WD roads, but at least 0.5 mile from all improved roads, although they may not be in sight.	On or near improved country roads, but at least 0.5 mile from all highways.	On or near primary highways, but still within a rural area.	On or near primary highways, municipal streets, and roads within towns or cities.
b. Naturalness					
Undisturbed natural landscape	Naturally appearing landscape having modifications not readily noticeable.	Naturally appearing landscape except for obvious primitive roads.	Landscape partially modified by roads, utility lines, etc., but none overpower natural landscape features.	Natural landscape substantially modified by agriculture or industrial development.	Urbanized development dominates this landscape.
c. Facilities					
None	Some primitive trails made of natural materials such as log bridges and carved wooden signs.	Maintained and marked trails, simple trailhead developments, improved signs, and very basic toilets.	Improved yet modest, rustic facilities such as campgrounds, restrooms, trails, and interpretive signs.	Modern facilities such as campgrounds, group shelters, boat launches, and occasional exhibits.	Elaborate, full-service facilities such as laundry, groceries, and bookstores.
Social – Visitor Use and Users: Character of Recreation and Tourism Use					
d. Group Size					
Fewer than or equal to 3 people per group.	4 to 6 people per group.	7 to 12 people per group.	13 to 25 people per group.	26 to 50 people per group.	More than 50 people per group.

Table J-1. Characterization of Settings (Continued)

Primitive	Semi-primitive Non-motorized	Semi-primitive Motorized	Roaded Natural	Rural	Urban
Social – Visitor Use and Users: Character of Recreation and Tourism Use, continued					
e. Contacts (with other users/user groups)					
Fewer than 3 encounters per day at campsites and fewer than 6 encounters per day on travel routes.	3 to 6 encounters per day off travel routes (e.g., campsites) and 7 to 15 encounters per day on travel routes.	7 to 14 encounters per day off travel routes (e.g., staging areas) and 15 to 29 encounters per day en route.	15 to 29 encounters per day off travel routes (e.g., campgrounds) and 30 or more encounters per day en route.	People seem to be everywhere, but human contact is intermittent.	Other people consistently in view.
f. Evidence of Use					
Only footprints may be observed.	Footprints plus slight vegetation trampling at campsites and travel routes. Only infrequent litter.	Vehicle tracks and occasional litter and soil erosion. Vegetation becoming worn.	Well-worn soils and vegetation, but often gravel surfaced for erosion control. Litter may be frequent.	Paved routes protect soils and vegetation, but noise, litter, and facility impacts are pervasive.	A busy place with what seems like constant noise; unavoidable litter seems to be a lifestyle choice.
Administrative – Administrative and Service Setting: How Public Land Managers, County Commissioners and Municipal Governments, and Local Businesses Care for the Area and Serve Visitors and Local Residents					
g. Visitor Services					
None is available on-site.	Basic maps, but area personnel seldom available to provide on-site assistance.	Area brochures and maps, plus area personnel occasionally present to provide on-site assistance.	Information materials describe recreation areas and activities. Area personnel are periodically available.	Everything described to the left in this row, and descriptions of experiences and benefits available. Area personnel do on-site education.	Everything described to the left of this row, plus regularly scheduled on-site outdoor skills demonstrations and clinics.
h. Management Controls					
No visitor controls apparent. No use limits. Enforcement presence may be very rare.	Signs at key access points on basic user ethics. May have back country use restrictions. Enforcement presence rare.	Occasional regulatory signing. Motorized and mechanized use restrictions. Random enforcement presence.	Rules clearly posted with some seasonal or day-of-week restrictions. Periodic enforcement presence.	Regulations prominent. Total use limited by permit, reservation, etc. Routine enforcement presence.	Continues enforcement to redistribute use and reduce user conflicts, hazards, and resource damage.
i. Mechanized Use					
None whatsoever.	Mountain bikes and perhaps other mechanized use, but all uses are non-motorized.	4WD, ATV, dirt bikes, or snowmobiles in addition to non-motorized, mechanized use.	2WD vehicles predominant, but also 4WD and non-motorized, mechanized use.	Ordinary highway auto and truck traffic is characteristic.	Wide variety of street vehicle and highway traffic is ever-present.

Appendix K

HAUL ROUTE USE DATA

Table K-1. Average Annual Daily Traffic Counts for Haul Routes within the Project Area (2007 to 2009)

Route	Start	End	Length (miles)	AADT 2007 (vehicles)	AADT 2008 (vehicles)	AADT 2009 (vehicles)
I 40	Exit 195 I-17 (Exit 345) - Flagstaff	Exit 198 Butler Ave	2.91	33,500	37,000	40,500
I 40	Exit 198 Butler Ave	Exit 201 SB 40 (4) / Country Club	2.75	29,500	29,000	29,500
I 40	Exit 201 SB 40 (4) / Country Club	Exit 204 Walnut Canyon Rd	3.76	19,500	19,500	20,000
I 40	Exit 204 Walnut Canyon Rd	Exit 207 Cosnino Rd	2.43	17,500	17,500	18,000
I 40	Exit 207 Cosnino Rd	Exit 211 Winona Rd	3.87	17,500	17,000	17,500
I 40	Exit 211 Winona Rd	Exit 219 Twin Arrows Rd / Pollock Ranch Rd	8.42	16,500	14,500	14,500
I 40	Exit 219 Twin Arrows Rd / Pollock Ranch Rd	Exit 225 Buffalo Range Rd	5.49	16,500	16,500	15,500
I 40	Exit 225 Buffalo Range Rd	Exit 230 Canyon Diablo Rd / Two Guns	5.38	16,500	16,000	15,500
I 40	Exit 230 Canyon Diablo Rd / Two Guns	Exit 233 Meteor Crater Rd / Sunshine Rd	3.43	16,000	15,500	15,500
I 40	Exit 233 Meteor Crater Rd / Sunshine Rd	Exit 239 Dennison Rd / Meteor City Rd	5.79	16,500	16,000	16,000
I 40	Exit 239 Dennison Rd / Meteor City Rd	Exit 245 SR 99 North / Leupp Rd	5.74	16,500	16,000	15,500
I 40	Exit 245 SR 99 North / Leupp Rd	Exit 252 SB 40 (6) / Hipkoe Dr	6.72	16,500	16,000	16,000
I 40	Exit 252 SB 40 (6) / Hipkoe Dr	Exit 253 North Park Dr	1.50	19,000	16,000	16,500
I 40	Exit 253 North Park Dr	Exit 255 SB 40 (6) / Oak Rd	2.12	18,000	16,000	16,000
I 40	Exit 255 SB 40 (6) / Oak Rd	Exit 257 SR 87 North	1.95	17,000	16,000	16,500
I 40	Exit 257 SR 87 North	Exit 264 Hibbard Rd	7.07	17,000	16,000	15,500
I 40	Exit 264 Hibbard Rd	Exit 269 Jackrabbit Rd	5.22	17,000	15,500	15,500
I 40	Exit 269 Jackrabbit Rd	Exit 274 SB 40 (7) - West end of Joseph City	4.75	16,500	14,500	16,000
I 40	Exit 274 SB 40 (7) - West end of Joseph City	Exit 277 SB 40 (7) - East end of Joseph City	2.34	15,500	16,000	16,000
I 40	Exit 277 SB 40 (7) - East end of Joseph City	Exit 280 Hunt Rd	3.57	14,000	13,500	13,500
I 40	Exit 280 Hunt Rd	Exit 283 Perkins Valley	3.01	14,000	17,500	15,500
I 40	Exit 283 Perkins Valley	Exit 285 SB 40 (8) / Hopi Dr - West end of Holbrook	1.52	14,500	14,500	14,000
I 40	Exit 285 SB 40 (8) / Hopi Dr - West end of Holbrook	Exit 286 SB 40 (8) / Navajo Rd	1.71	15,000	14,500	14,000
I 40	Exit 286 SB 40 (8) / Navajo Rd	Exit 289 SB 40 (8) / SR 77 - East end of Holbrook	2.62	15,000	15,000	13,500
I 40	Exit 289 SB 40 (8) / SR 77 - East end of Holbrook	Exit 292 SR 77 North	3.30	17,000	17,000	15,000
I 40	Exit 292 SR 77 North	Exit 294 Sun Valley Rd / Arntz Rd	1.72	15,000	15,000	15,000

Table K-1. Average Annual Daily Traffic Counts for Haul Routes within the Project Area (2007 to 2009), Continued

Route	Start	End	Length (miles)	AADT 2007 (vehicles)	AADT 2008 (vehicles)	AADT 2009 (vehicles)
I 40	Exit 294 Sun Valley Rd / Arntz Rd	Exit 300 Goodwater Rd	6.01	15,000	15,500	15,000
I 40	Exit 300 Goodwater Rd	Exit 303 Adamana Rd	3.08	15,000	15,000	14,500
I 40	Exit 303 Adamana Rd	Exit 311 Petrified Forest Rd / Painted Desert	7.94	15,000	14,500	14,000
I 40	Exit 311 Petrified Forest Rd / Painted Desert	Exit 320 Pinto Rd	8.45	15,000	13,000	12,500
I 40	Exit 320 Pinto Rd	Exit 325 Navajo Rd	5.89	15,500	14,000	13,000
I 40	Exit 325 Navajo Rd	Exit 330 McCarroll Rd	4.11	15,500	14,500	13,000
I 40	Exit 330 McCarroll Rd	Exit 333 US 191 North - Chambers	3.40	15,500	14,000	12,500
I 40	Exit 333 US 191 North - Chambers	Exit 339 US 191 South - Sanders	6.11	15,500	14,500	14,000
I 40	Exit 339 US 191 South - Sanders	Exit 341 Ortega Rd	2.30	16,500	14,500	14,000
SR 64	I-40 (Exit 167) - East of Williams	Spring Valley Rd	5.63	5,400	5,100	5,100
SR 64	Spring Valley Rd	US 180 - Valle	22.37	3,600	3,300	3,100
SR 64	US 180 East - Valle	Grand Canyon Airport Rd (Old SS 64)	21.18	4,400	4,300	4,600
SR 64	Grand Canyon Airport Rd (Old SS 64)	Entrance Rd / Road to Grand Canyon Park HQ	2.44	5,800	6,200	6,600
SR 64	Leave Grand Canyon NP, Enter Kaibab NF	US 89	27.85	1,800	1,500	2,500
SR 98	US 89 - Page	BIA Rte 20 / Coppermine Rd	2.58	2,000	2,200	2,200
SR 98	BIA Rte 20 / Coppermine Rd	Navajo Generating Station Rd	3.60	5,300	5,200	5,300
SR 98	Navajo Generating Station Rd	Navajo Mountain Rd	48.40	2,300	2,300	2,400
SR 98	Navajo Mountain Rd	US 160	12.31	2,200	2,100	2,200
SR 389	Utah State Line - Colorado City	Central Rd	2.52	3,600	3,600	3,600
SR 389	Central Rd	Cane Beds Rd	2.26	3,600	3,600	3,600
SR 389	Cane Beds Rd	Pipe Springs National Monument Rd	14.41	2,000	1,900	1,900
SR 389	Pipe Sprigs National Monument Rd	BIA 50 / Pratt St	11.21	2,400	2,300	2,300
SR 389	BIA 50 / Pratt St	US 89A - Fredonia	2.19	2,500	2,500	2,500
US 89	SB 40 (4) / Country Club Dr	East Flagstaff Mall Entrance	0.37	26,500	26,000	26,500
US 89	MP 420.38 (Beg Seg N Flag CL)	Townsend - Winona Rd	0.50	17,000	16,500	30,500
US 89	Townsend - Winona Rd	Silver Saddle Rd	1.89	17,000	16,500	16,500
US 89	Silver Saddle Rd	Brandis Way	4.03	8,300	8,200	10,500
US 89	Brandis Way	Sunset Crater Wupatki NF-545	17.99	6,200	6,600	7,000
US 89	Sunset Crater Wupatki NF-545	Grey Mountain Trading Post	12.32	6,900	6,300	6,500
US 89	Gray MountainTrading Post	SR 64	8.10	7,300	6,600	7,000
US 89	SR 64	US 160 East	15.59	7,900	6,900	7,300
US 89	US 160 East	US 89A - Bitter Springs	43.12	4,000	3,500	4,000

Table K-1. Average Annual Daily Traffic Counts for Haul Routes within the Project Area (2007 to 2009), Continued

Route	Start	End	Length (miles)	AADT 2007 (vehicles)	AADT 2008 (vehicles)	AADT 2009 (vehicles)
US 89	US 89A - Bitter Springs	SR 98 - Page	22.27	3,500	3,400	3,600
US 89	SR 98 - Page	Haul Rd	0.75	5,100	5,200	7,300
US 89	Haul Rd	Lake Powell Blvd (South Leg) - Page	0.29	8,600	8,500	6,500
US 89	Lake Powell Blvd (South Leg) - Page	Lake Powell Blvd (North Leg) - Page	1.28	6,600	6,500	7,200
US 89	Lake Powell Blvd (North Leg) - Page	Wahweap Rd and Visitor Center entrance	1.33	7,700	6,800	7,300
US 89	Wahweap Rd and Visitor Center entrance	Utah State Line	7.15	4,300	3,700	4,400
US 160	US 89	Kerley Rd.	7.03	5,400	4,800	5,100
US 160	Kerley Rd.	Peshlakai Ave	3.46	11,500	11,500	13,000
US 160	Peshlakai Ave	Warrior Dr	0.40	11,500	11,500	13,000
US 160	Warrior Dr	BIA 21	21.23	3,900	3,800	4,100
US 160	BIA 21	SR 98	18.04	3,900	3,800	3,500
US 160	SR 98 West	SR 564	12.66	4,500	4,100	4,300
US 160	SR 564	Tsiegi Canyon Rd.	7.99	4,600	4,500	4,900
US 160	Tsiegi Canyon Rd.	US 163 North - Kayenta	10.58	2,500	2,400	2,800
US 160	BIA 59	IND Rd.	11.54	2,500	2,400	2,800
US 160	US 191 - Mexican Water	BIA Rte 12 North - Red Mesa	2.32	3,100	2,700	3,300
US 160	BIA Rte 12 - Red Mesa	US 64 East - Teec Nos Pos	28.25	3,000	4,000	3,400
US 160	US 64 East - Teec Nos Pos	New Mexico State Line	5.33	1,900	1,700	1,700
US 163	US 160 - Kayenta	BIA Rte 6485 - Kayenta	1.34	12,500	14,000	14,000
US 163	BIA Rte 6485 - Kayenta	MP 397	2.14	2,600	2,500	2,600
US 163	MP 397	Utah State Line	19.71	2,600	2,500	2,600
US 191	BIA Rte 28	SR 264 East - East end of Ganado	14.46	1,300	1,200	1,200
US 191	SR 264 / BIA Rte 15 - West of Ganado	BIA Rte 4	24.24	2,600	2,600	2,600
US 191	BIA Rte 4	BIA Rte 102 / Rd to Chinle Hospital	4.91	4,200	4,200	4,200
US 191	BIA Rte 102 / Chinle Hospital entrance	BIA Rte 7 - Chinle	1.15	7,800	8,700	8,800
US 191	BIA Rte 7 - Chinle	BIA Rte 59 - Many Farms	13.90	4,600	4,500	4,500
US 191	BIA Rte 59 - Many Farms	BIA Rte 12 - Roound Rock	16.15	1,400	1,500	1,500
US 191	BIA Rte 12 - Round Rock	BIA Rte 35 - Rock Point	17.24	1,000	1,100	1,100
US 191	BIA Rte 35 - Rock Point	US 160 - Mexican Water	15.20	1,000	1,000	1,000
US 89A	US 89 - Bitter Springs	Marble Canyon	14.04	1,200	1,100	1,100
US 89A	Marble Canyon	SR 67 - Jacob Lake	41.33	1,000	1,000	1,000
US 89A	SR 67 - Jacob Lake	Ryan Rd	28.43	1,300	1,300	1,300
US 89A	Ryan Rd	SR 389 - Fredonia	1.51	1,600	1,600	1,600
US 89A	SR 389 - Fredonia	Utah State Line	3.80	4,400	4,000	4,100

Table K-2. Haul Trips by Parcel

	Total Haul Trips by Parcel	Percent of Total	Annual (haul trips)	Daily (haul trips)
Alternative A				
North Parcel	221,298	69.70%	11,065	35
East Parcel	22,240	7.00%	1,112	4
South Parcel	73,967	23.30%	3,698	12
Total	*317,505*		*15,875*	*51*
Alternative B				
North Parcel	98,978	93.18%	4,949	16
East Parcel	0	0.00%	0	0
South Parcel	7,247	6.82%	362	1
Total	*106,225*		*5,311*	*17*
Alternative C				
North Parcel	132,338	71.90%	6,617	21
East Parcel	11,120	6.04%	556	2
South Parcel	40,607	22.06%	2,030	7
Total	*184,065*		*9,203*	*29*
Alternative D				
North Parcel	210,178	76.98%	10,509	34
East Parcel	11,120	4.07%	556	2
South Parcel	51,727	18.95%	2,586	8
Total	*273,025*		*13,651*	*44*

Table K-3. Estimated Impact of Ore Hauling on Traffic Conditions for Alternative A

Route	Existing (AADT 2009) Low (vehicles)	Existing (AADT 2009) High (vehicles)	Alternative A (hauls per day)	% Low Change	% High Change
North Parcel					
Arizona					
SR 98	2,200	5,300	35	1.61%	0.67%
SR 398	1,900	3,600	35	1.87%	0.99%
US 89	3,600	30,500	35	0.99%	0.12%
US 160	1,700	13,000	35	2.09%	0.27%
US 163	2,600	14,000	35	1.36%	0.25%
US 191	1,000	8,800	35	3.55%	0.40%
US 89A	1,000	4,100	35	3.55%	0.86%
Utah					
US 191	1,500	5,000	35	2.36%	0.71%
US 89A	4,200	4,200	35	0.84%	0.84%
US 89	2,300	7,800	35	1.54%	0.45%
Average				1.98%	0.56%
East Parcel					
Arizona					
US 89	3,600	30,500	4	0.10%	0.01%
US 160	1,700	13,000	4	0.21%	0.03%
US 163	2,600	14,000	4	0.14%	0.03%
US 191	1,000	8,800	4	0.36%	0.04%
US 89A	1,000	4,100	4	0.36%	0.09%
Utah					
US 191	1,500	5,000	4	0.24%	0.07%
US 89A	4,200	4,200	4	0.08%	0.08%
US 89	2,300	7,800	4	0.15%	0.05%
Average				0.20%	0.05%
South Parcel					
Arizona					
SR 64	2,500	6,600	12	0.47%	0.18%
I-40	12,500	40,500	12	0.09%	0.03%
US 89	3,600	30,500	12	0.33%	0.04%
US 160	1,700	13,000	12	0.70%	0.09%
US 163	2,600	14,000	12	0.46%	0.08%
US 191	1,000	8,800	12	1.19%	0.13%
Utah					
US 191	1,500	5,000	12	0.79%	0.24%
US 89	2,300	7,800	12	0.52%	0.15%
Average				*0.57%*	*0.12%*

Table K-4. Estimated Impact of Ore Hauling on Traffic Conditions for Alternative B

Route	Existing (AADT 2009) Low (vehicles)	Existing (AADT 2009) High (vehicles)	Alternative B (hauls per day)	% Low Change	% High Change
North Parcel					
Arizona					
SR 98	2,200	5,300	16	0.72%	0.30%
SR 398	1,900	3,600	16	0.83%	0.44%
US 89	3,600	30,500	16	0.44%	0.05%
US 160	1,700	13,000	16	0.93%	0.12%
US 163	2,600	14,000	16	0.61%	0.11%
US 191	1,000	8,800	16	1.59%	0.18%
US 89A	1,000	4,100	16	1.59%	0.39%
Utah					
US 191	1,500	5,000	16	1.06%	0.32%
US 89A	4,200	4,200	16	0.38%	0.38%
US 89	2,300	7,800	16	0.69%	0.20%
Average				*0.88%*	*0.25%*
East Parcel					
Arizona					
US 89	3,600	30,500	0	0.00%	0.00%
US 160	1,700	13,000	0	0.00%	0.00%
US 163	2,600	14,000	0	0.00%	0.00%
US 191	1,000	8,800	0	0.00%	0.00%
US 89A	1,000	4,100	0	0.00%	0.00%
Utah					
US 191	1,500	5,000	0	0.00%	0.00%
US 89A	4,200	4,200	0	0.00%	0.00%
US 89	2,300	7,800	0	0.00%	0.00%
Average				*0.00%*	*0.00%*
South Parcel					
Arizona					
SR 64	2,500	6,600	1	0.05%	0.02%
I-40	12,500	40,500	1	0.01%	0.00%
US 89	3,600	30,500	1	0.03%	0.00%
US 160	1,700	13,000	1	0.07%	0.01%
US 163	2,600	14,000	1	0.04%	0.01%
US 191	1,000	8,800	1	0.12%	0.01%
Utah					
US 191	1,500	5,000	1	0.08%	0.02%
US 89	2,300	7,800	1	0.05%	0.01%
Average				*0.06%*	*0.01%*

Table K-5. Estimated Impact of Ore Hauling on Traffic Conditions for Alternative C

Route	Existing (AADT 2009) Low (vehicles)	Existing (AADT 2009) High (vehicles)	Alternative C (hauls per day)	% Low Change	% High Change
North Parcel					
Arizona					
SR 98	2,200	5,300	21	0.96%	0.40%
SR 398	1,900	3,600	21	1.12%	0.59%
US 89	3,600	30,500	21	0.59%	0.07%
US 160	1,700	13,000	21	1.25%	0.16%
US 163	2,600	14,000	21	0.82%	0.15%
US 191	1,000	8,800	21	2.12%	0.24%
US 89A	1,000	4,100	21	2.12%	0.52%
Utah					
US 191	1,500	5,000	21	1.41%	0.42%
US 89A	4,200	4,200	21	0.50%	0.50%
US 89	2,300	7,800	21	0.92%	0.27%
Average				*1.18%*	*0.33%*
East Parcel					
Arizona					
US 89	3,600	30,500	2	0.05%	0.01%
US 160	1,700	13,000	2	0.10%	0.01%
US 163	2,600	14,000	2	0.07%	0.01%
US 191	1,000	8,800	2	0.18%	0.02%
US 89A	1,000	4,100	2	0.18%	0.04%
Utah					
US 191	1,500	5,000	2	0.12%	0.04%
US 89A	4,200	4,200	2	0.04%	0.04%
US 89	2,300	7,800	2	0.08%	0.02%
Average				*0.10%*	*0.02%*
South Parcel					
Arizona					
SR 64	2,500	6,600	7	0.26%	0.10%
I-40	12,500	40,500	7	0.05%	0.02%
US 89	3,600	30,500	7	0.18%	0.02%
US 160	1,700	13,000	7	0.38%	0.05%
US 163	2,600	14,000	7	0.25%	0.05%
US 191	1,000	8,800	7	0.65%	0.07%
Utah					
US 191	1,500	5,000	7	0.43%	0.13%
US 89	2,300	7,800	7	0.28%	0.08%
Average				*0.31%*	*0.07%*

Table K-6. Estimated Impact of Ore Hauling on Traffic Conditions for Alternative D

Route	Existing (AADT 2009) Low (vehicles)	Existing (AADT 2009) High (vehicles)	Alternative D (hauls per day)	% Low Change	% High Change
North Parcel					
Arizona					
SR 98	2,200	5,300	34	1.53%	0.64%
SR 398	1,900	3,600	34	1.77%	0.94%
US 89	3,600	30,500	34	0.94%	0.11%
US 160	1,700	13,000	34	1.98%	0.26%
US 163	2,600	14,000	34	1.30%	0.24%
US 191	1,000	8,800	34	3.37%	0.38%
US 89A	1,000	4,100	34	3.37%	0.82%
Utah					
US 191	1,500	5,000	34	2.25%	0.67%
US 89A	4,200	4,200	34	0.80%	0.80%
US 89	2,300	7,800	34	1.46%	0.43%
Average				*1.88%*	*0.53%*
East Parcel					
Arizona					
US 89	3,600	30,500	2	0.05%	0.01%
US 160	1,700	13,000	2	0.10%	0.01%
US 163	2,600	14,000	2	0.07%	0.01%
US 191	1,000	8,800	2	0.18%	0.02%
US 89A	1,000	4,100	2	0.18%	0.04%
Utah					
US 191	1,500	5,000	2	0.12%	0.04%
US 89A	4,200	4,200	2	0.04%	0.04%
US 89	2,300	7,800	2	0.08%	0.02%
Average				*0.10%*	*0.02%*
South Parcel					
Arizona					
SR 64	2,500	6,600	8	0.33%	0.13%
I-40	12,500	40,500	8	0.07%	0.02%
US 89	3,600	30,500	8	0.23%	0.03%
US 160	1,700	13,000	8	0.49%	0.06%
US 163	2,600	14,000	8	0.32%	0.06%
US 191	1,000	8,800	8	0.83%	0.09%
Utah					
US 191	1,500	5,000	8	0.55%	0.17%
US 89	2,300	7,800	8	0.36%	0.11%
Average				*0.40%*	*0.08%*

Table K-7. Projected Annual Frequency of Roll Over Accidents

	Hauling Trips	Distance per Trip (miles)	Tons per Trip	Total Ton Miles (in millions)	Rollover Frequency*	Rollovers per Year
Alternative A						
North Parcel	221,298	275	25	1,521	0.00067	1.02
East Parcel	22,240	246	25	137	0.00067	0.09
South Parcel	73,967	256	25	473	0.00067	0.32
Total	*317,505*					*1.43*
Alternative B						
North Parcel	98,978	275	25	680	0.00067	0.46
East Parcel	0	246	25	-	0.00067	-
South Parcel	7,247	256	25	46	0.00067	0.03
Total	*106,225*					*0.49*
Alternative C						
North Parcel	132,338	275	25	910	0.00067	0.61
East Parcel	11,120	246	25	68	0.00067	0.05
South Parcel	40,607	256	25	260	0.00067	0.17
Total	*184,065*					*0.83*
Alternative D						
North Parcel	210,178	275	25	1,445	0.00067	0.97
East Parcel	11,120	246	25	68	0.00067	0.05
South Parcel	51,727	256	25	331	0.00067	0.22
Total	*273,025*					*1.24*

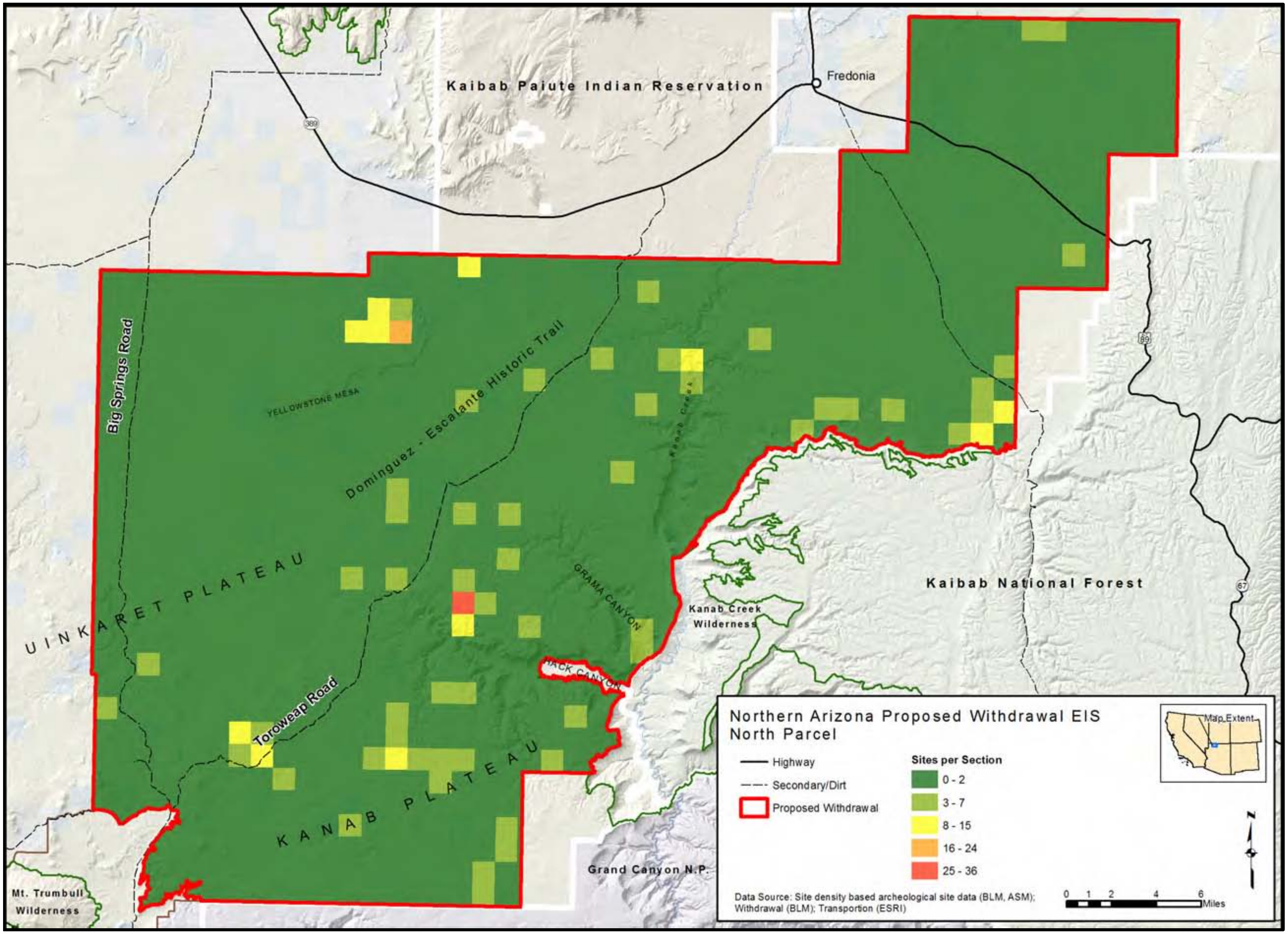


Figure 3.11-1. Archaeological site concentrations per section for the North Parcel.

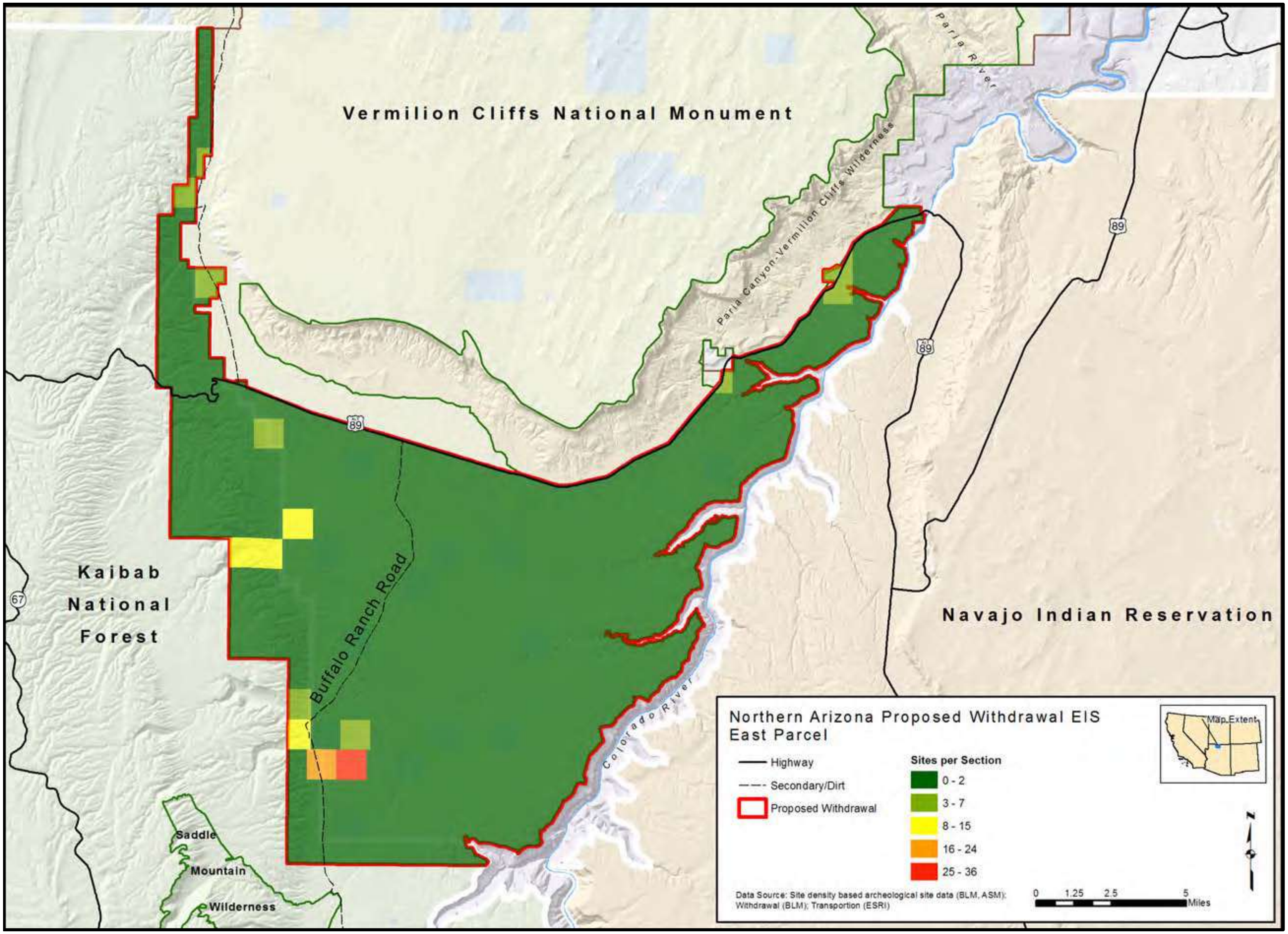


Figure 3.11-2. Archaeological site concentrations per section for the East Parcel.

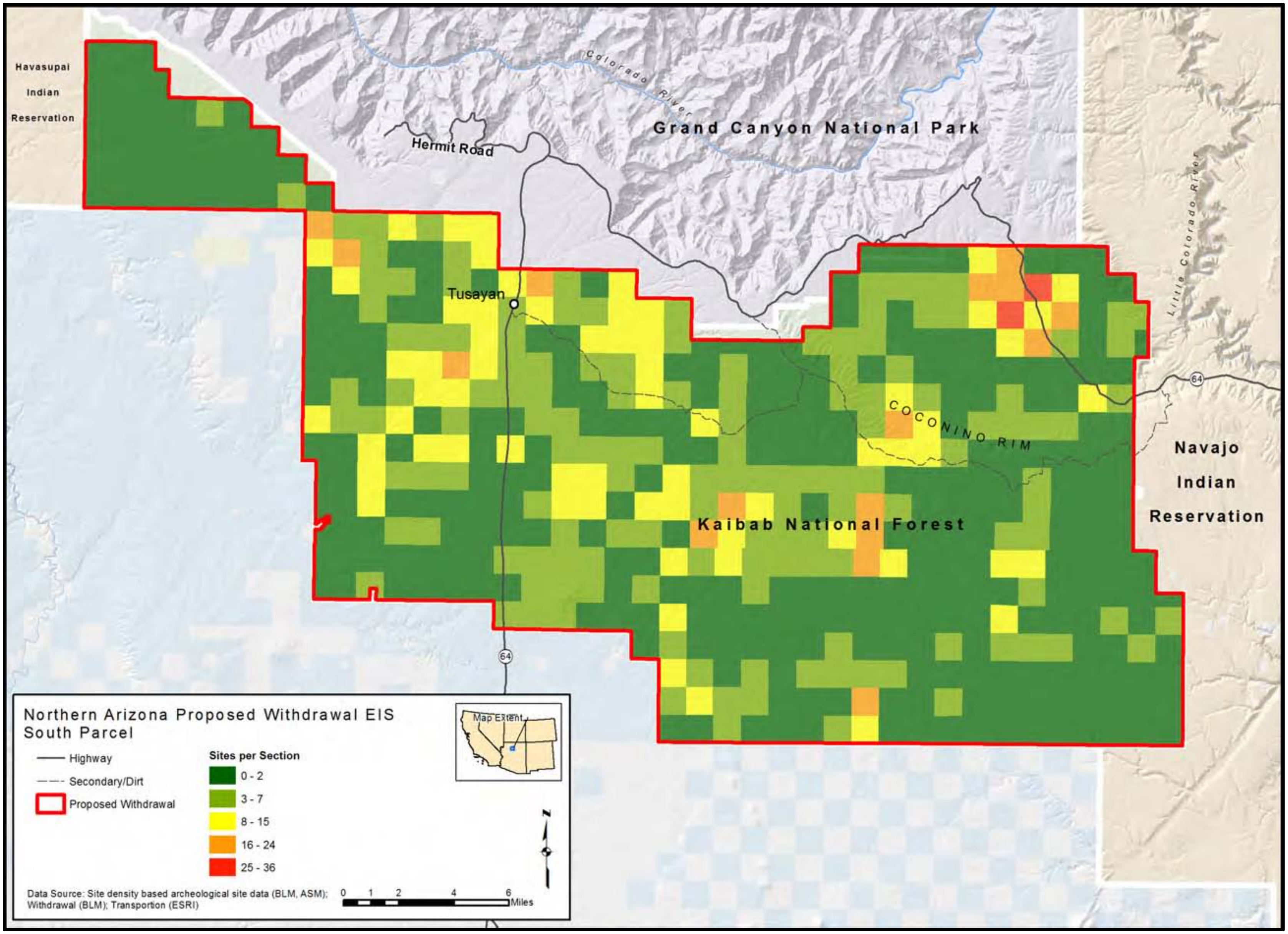


Figure 3.11-3. Archaeological site concentrations per section for the South Parcel.

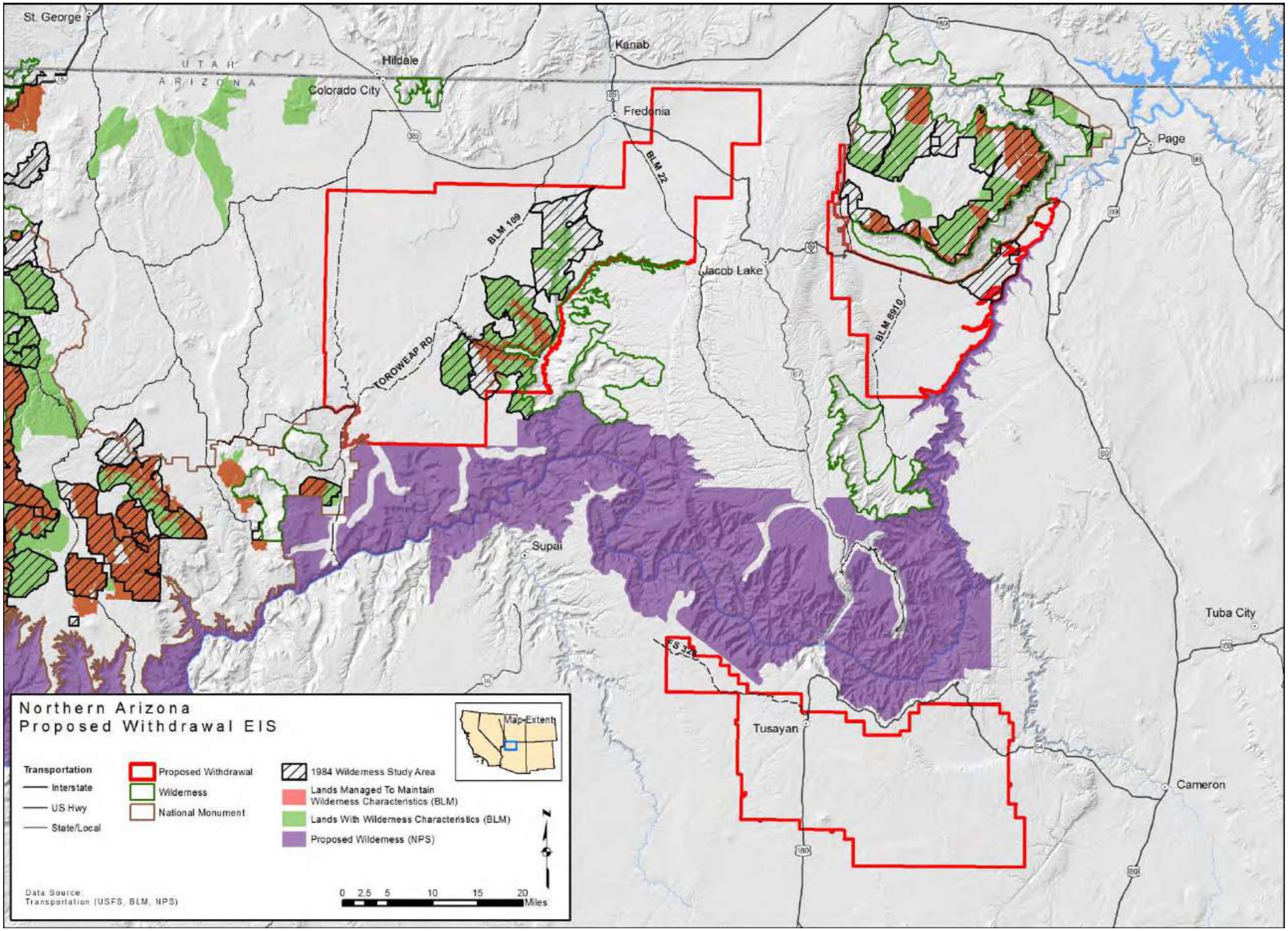


Figure 3.14-1. Wilderness characteristics.

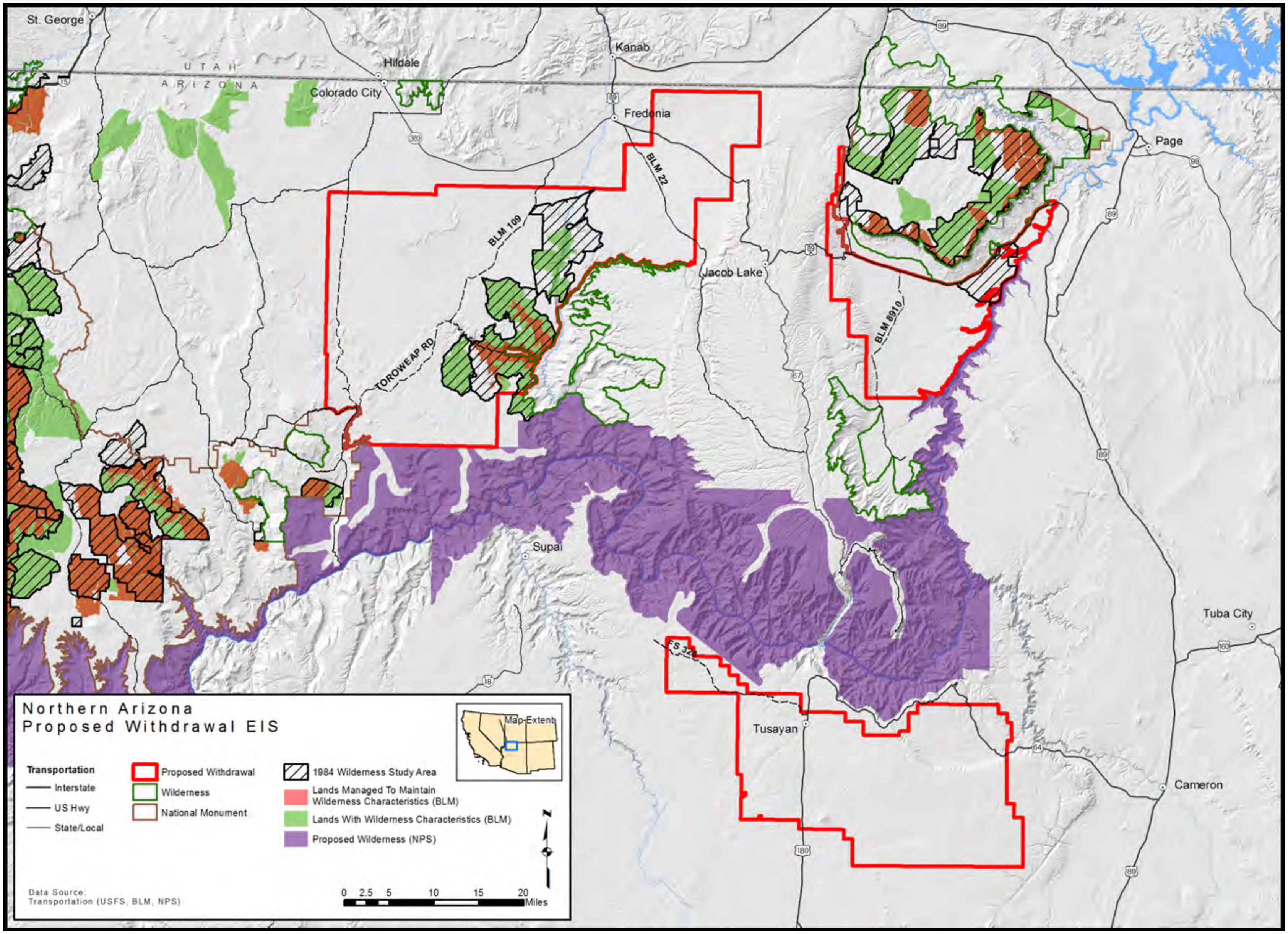


Figure 3.15-1. Recreation overview map.

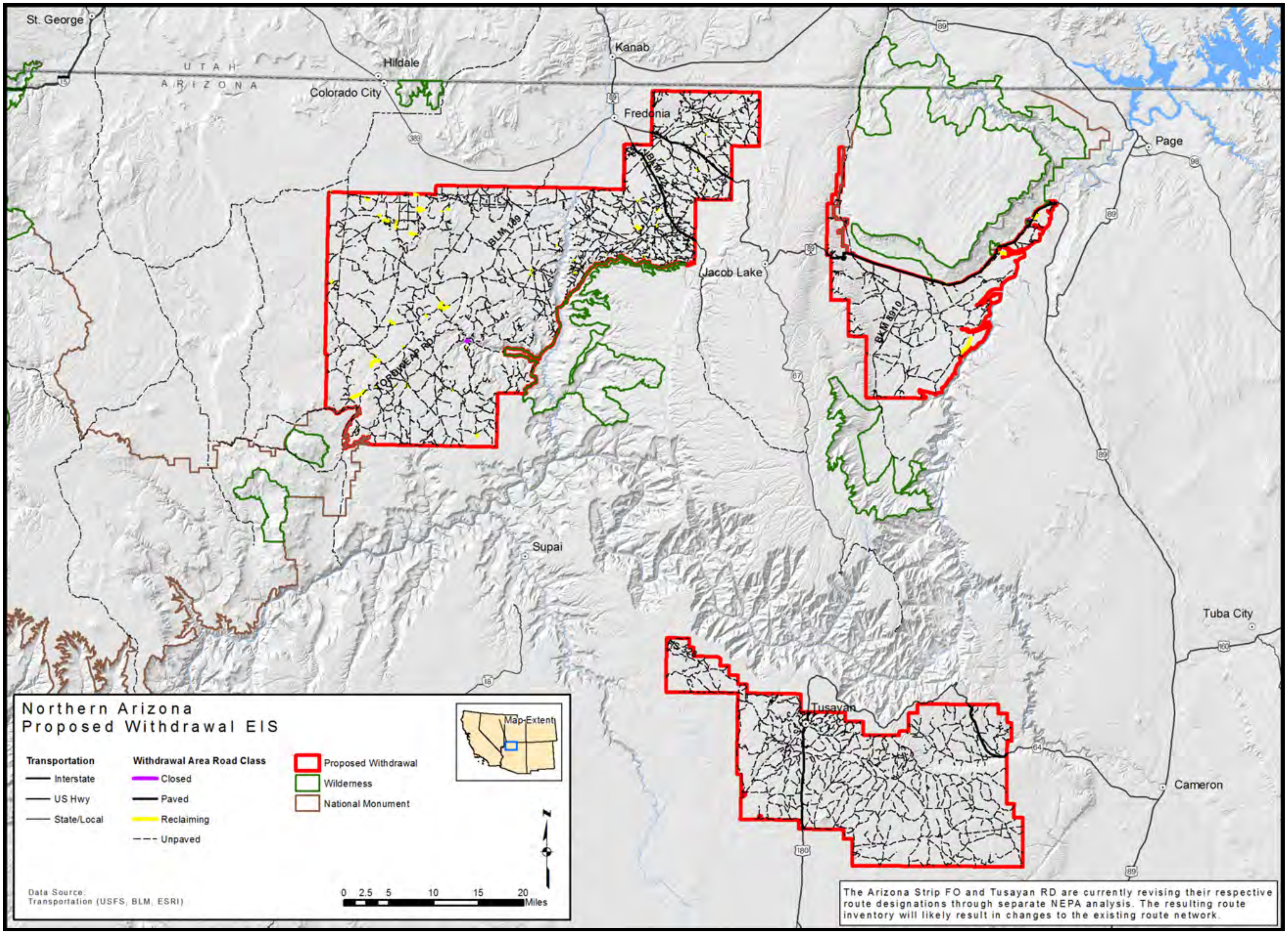


Figure 3.15-2. Transportation map.

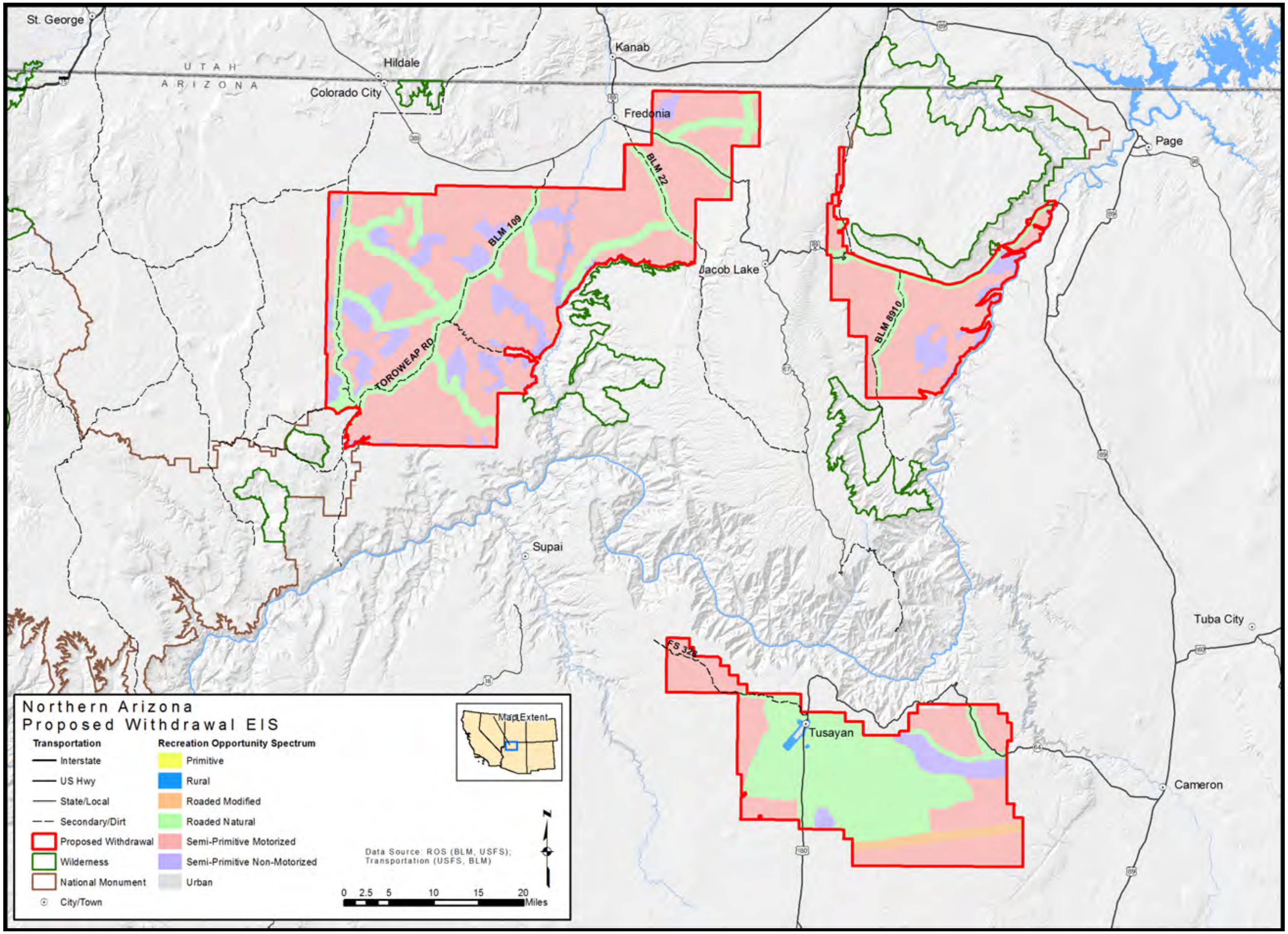


Figure 3.15-3. Recreation Opportunity Spectrum map.

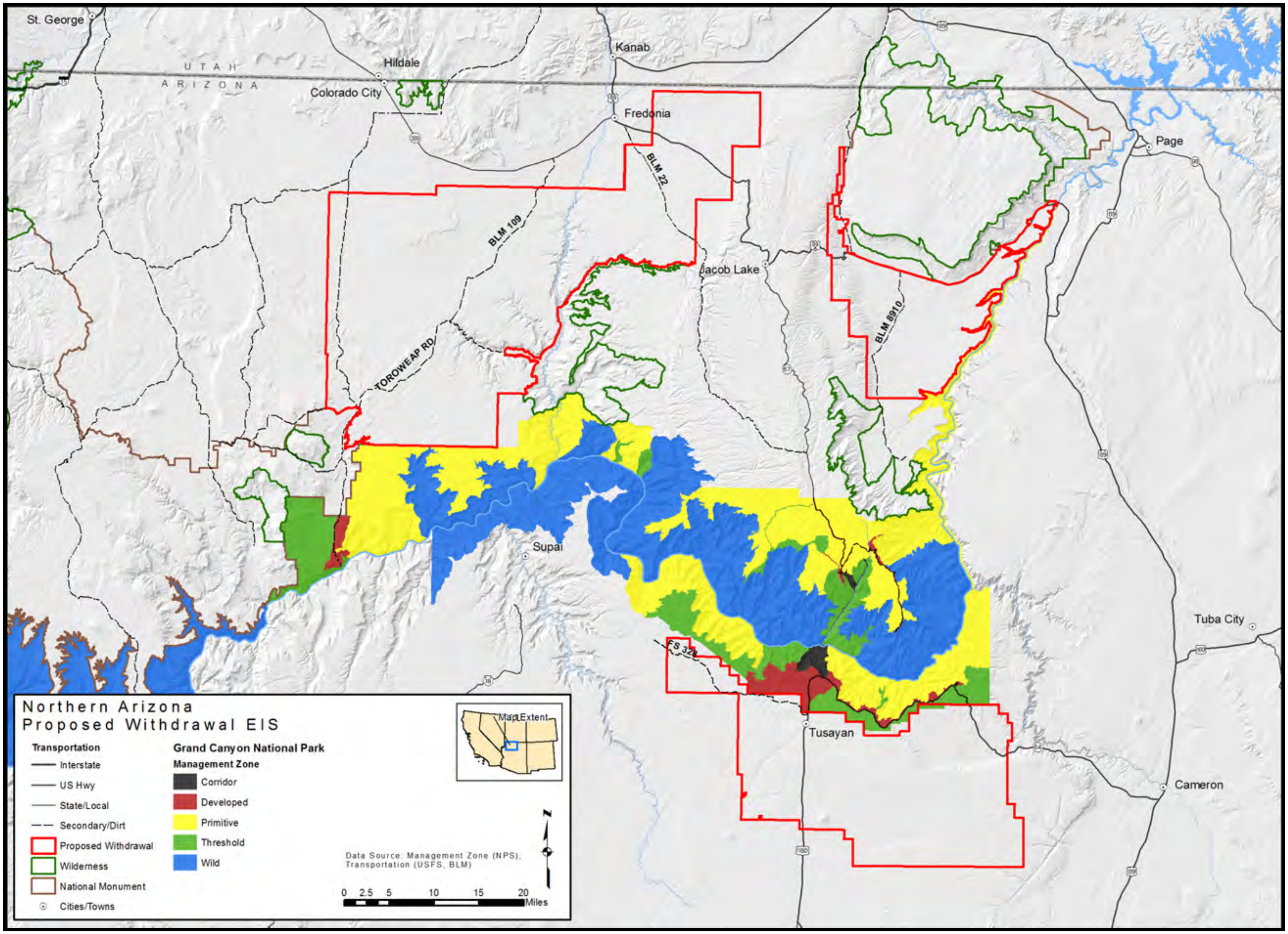


Figure 3.15-4. Park backcountry management zones map.

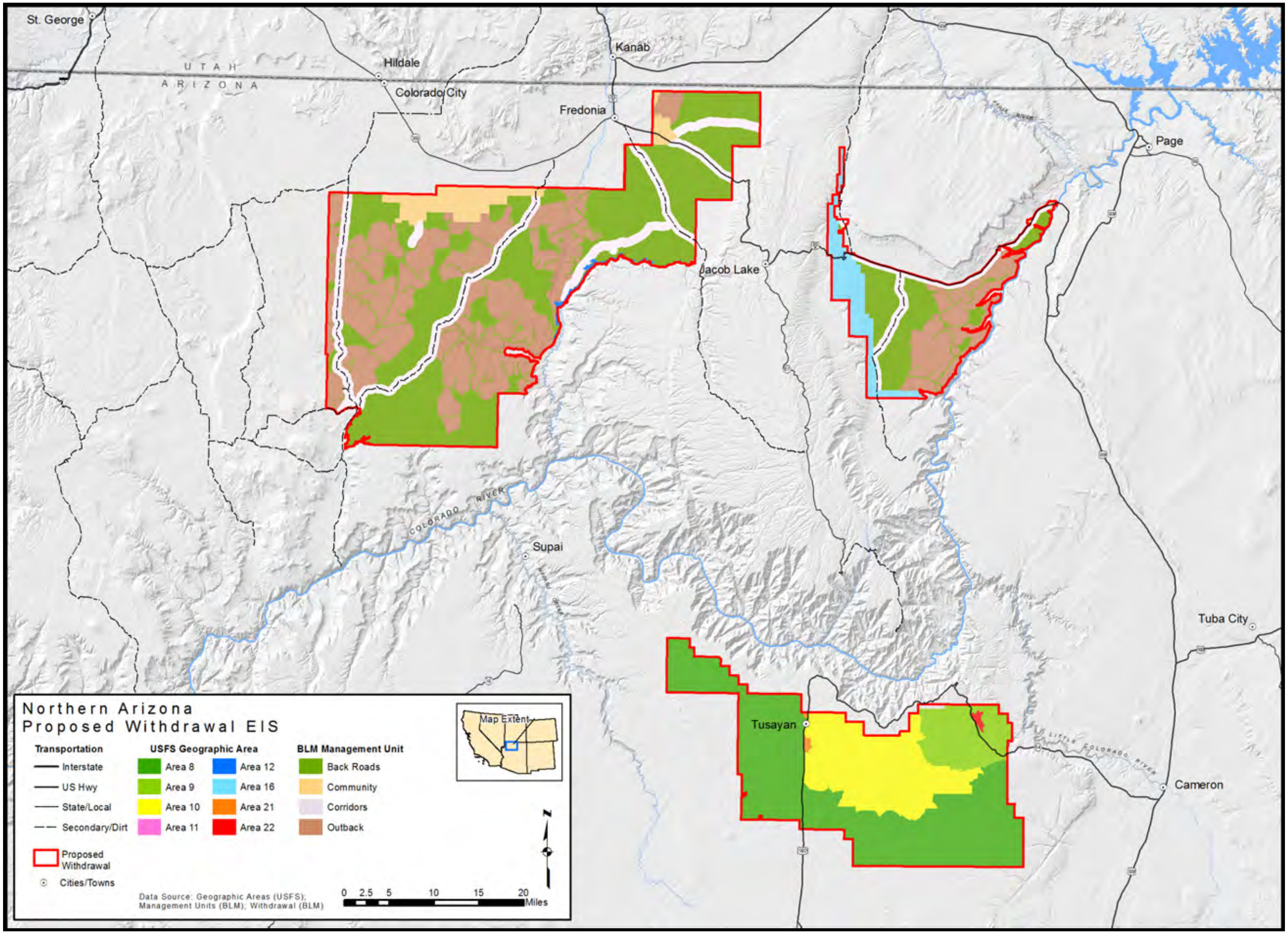


Figure 3.15-5. Management units within the proposed withdrawal area.

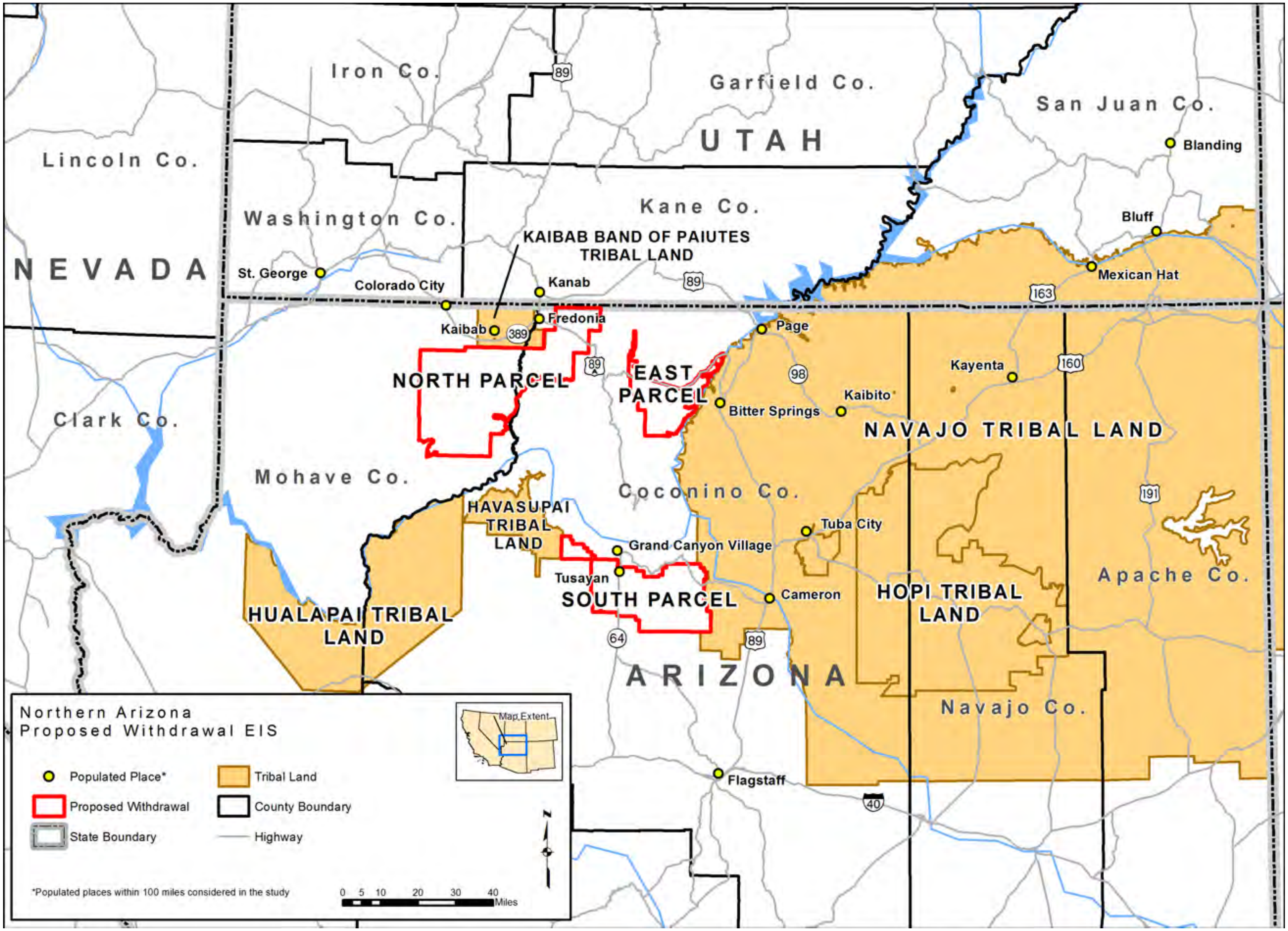


Figure 3.16-1. Population centers in the vicinity of the proposed withdrawal area.

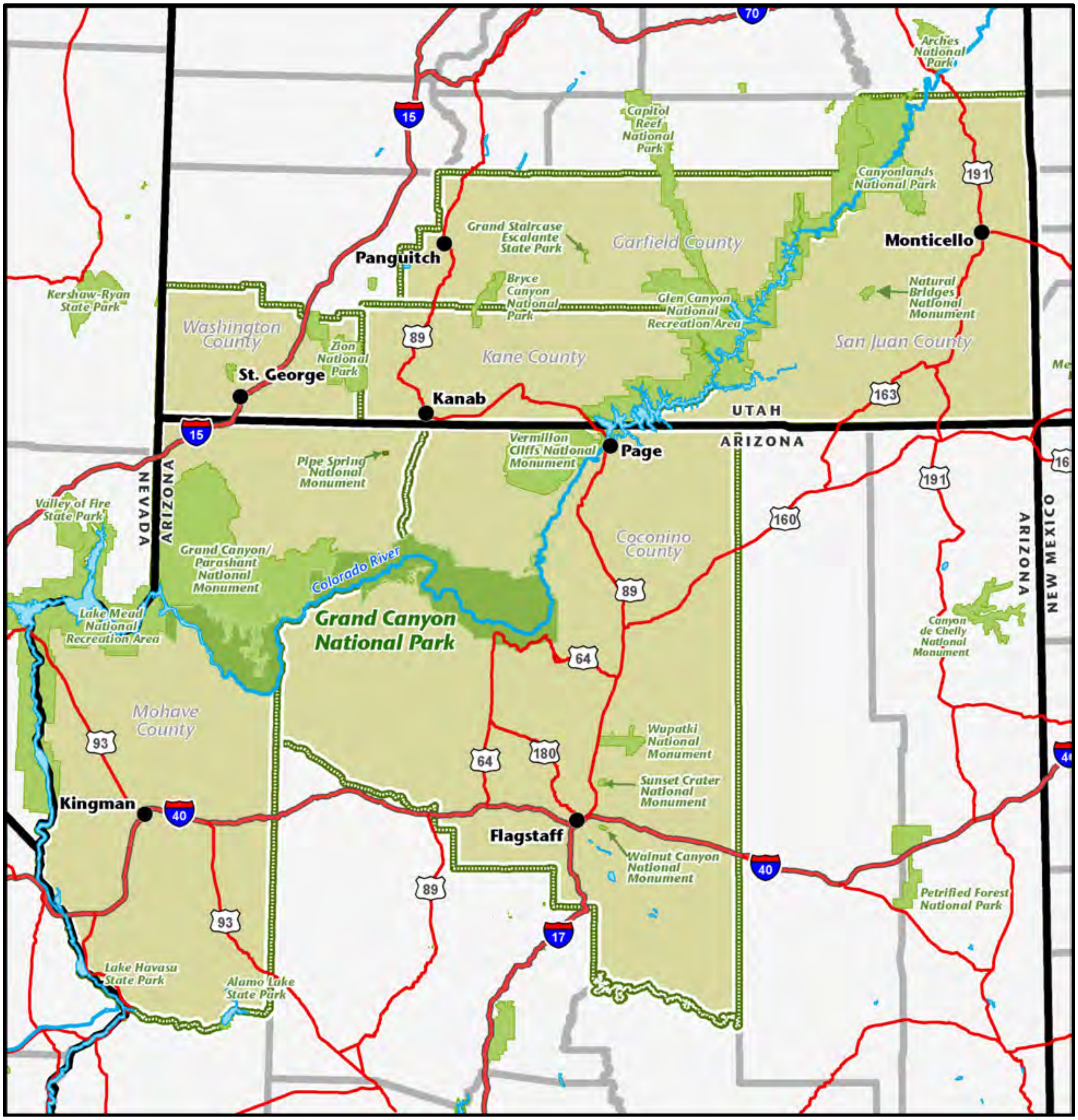


Figure 3.17-1. National parks and monuments in the study area.

Across the state, Utah residents tend to participate actively in nature-based recreation and consider the natural environment as a substantial contributor to quality of life, culture and heritage. However, southwest Utah, especially Kane and Garfield counties, is the most economically dependent on these resources as tourist attractions (Crispin et al. 2008; Krannich 2008).

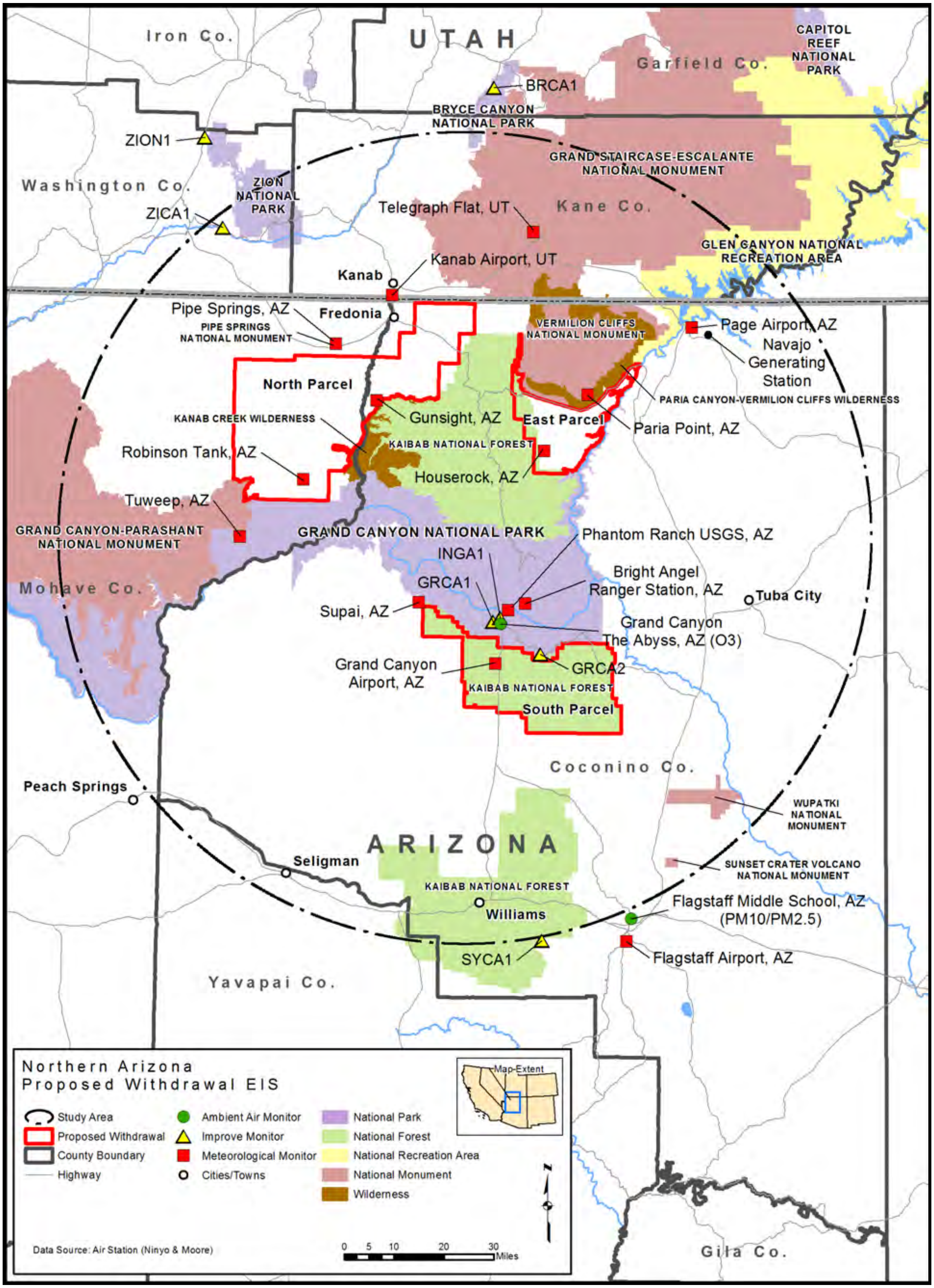


Figure 3.2-1. Air quality.

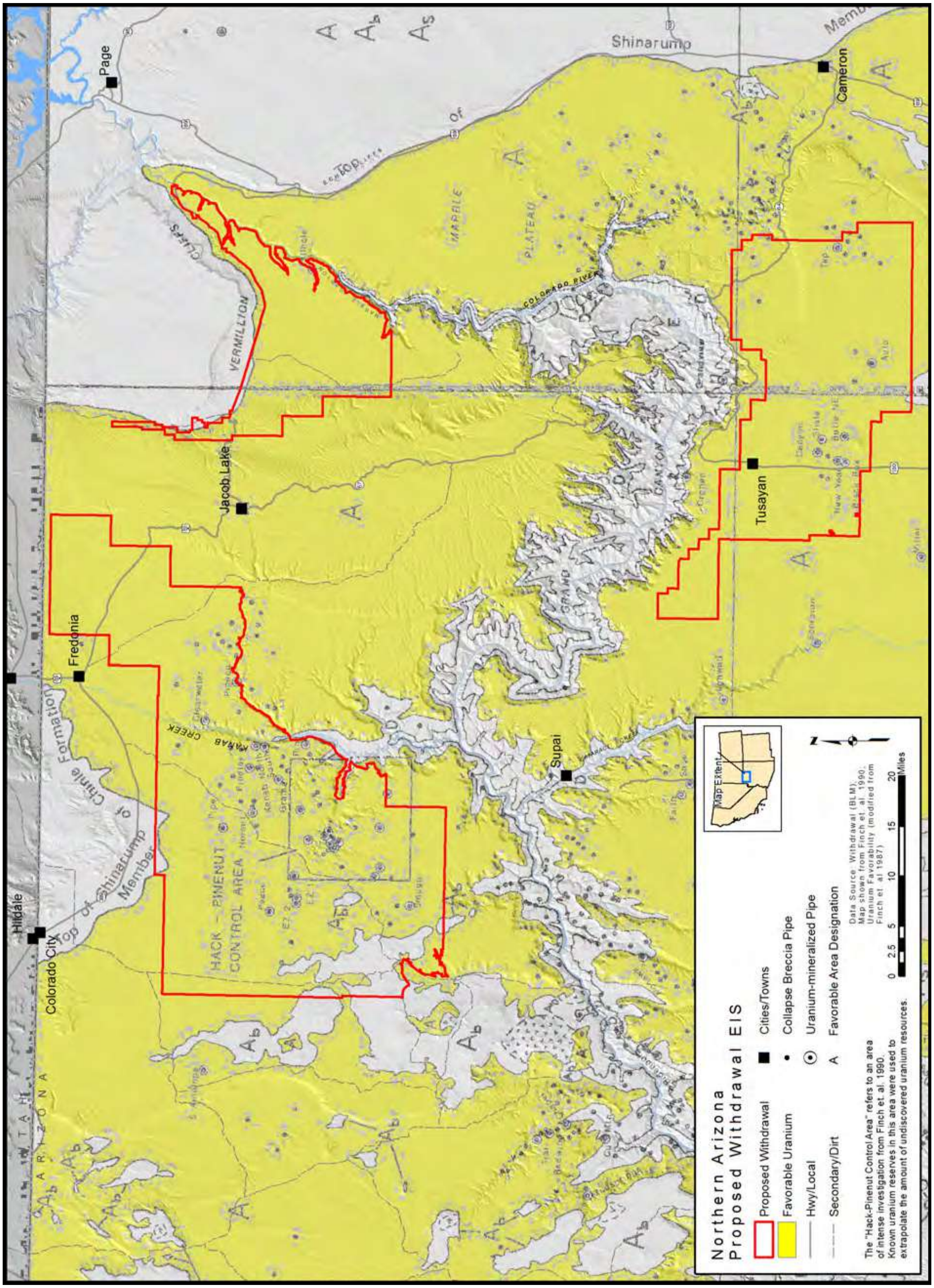


Figure 3.3-1. Areas favorable for uranium (from Finch et al. 1990).

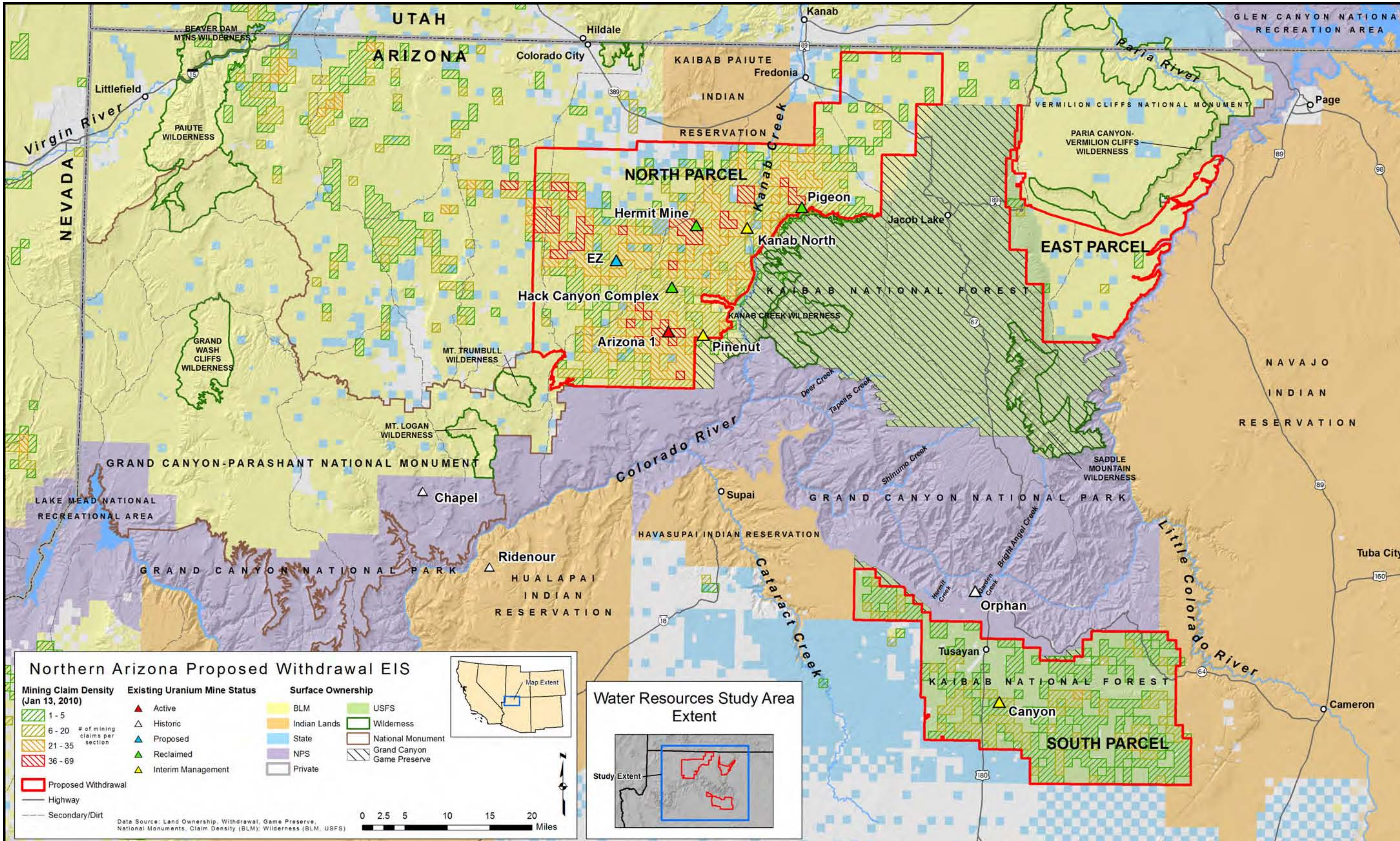


Figure 3.4-1. Regional location map.

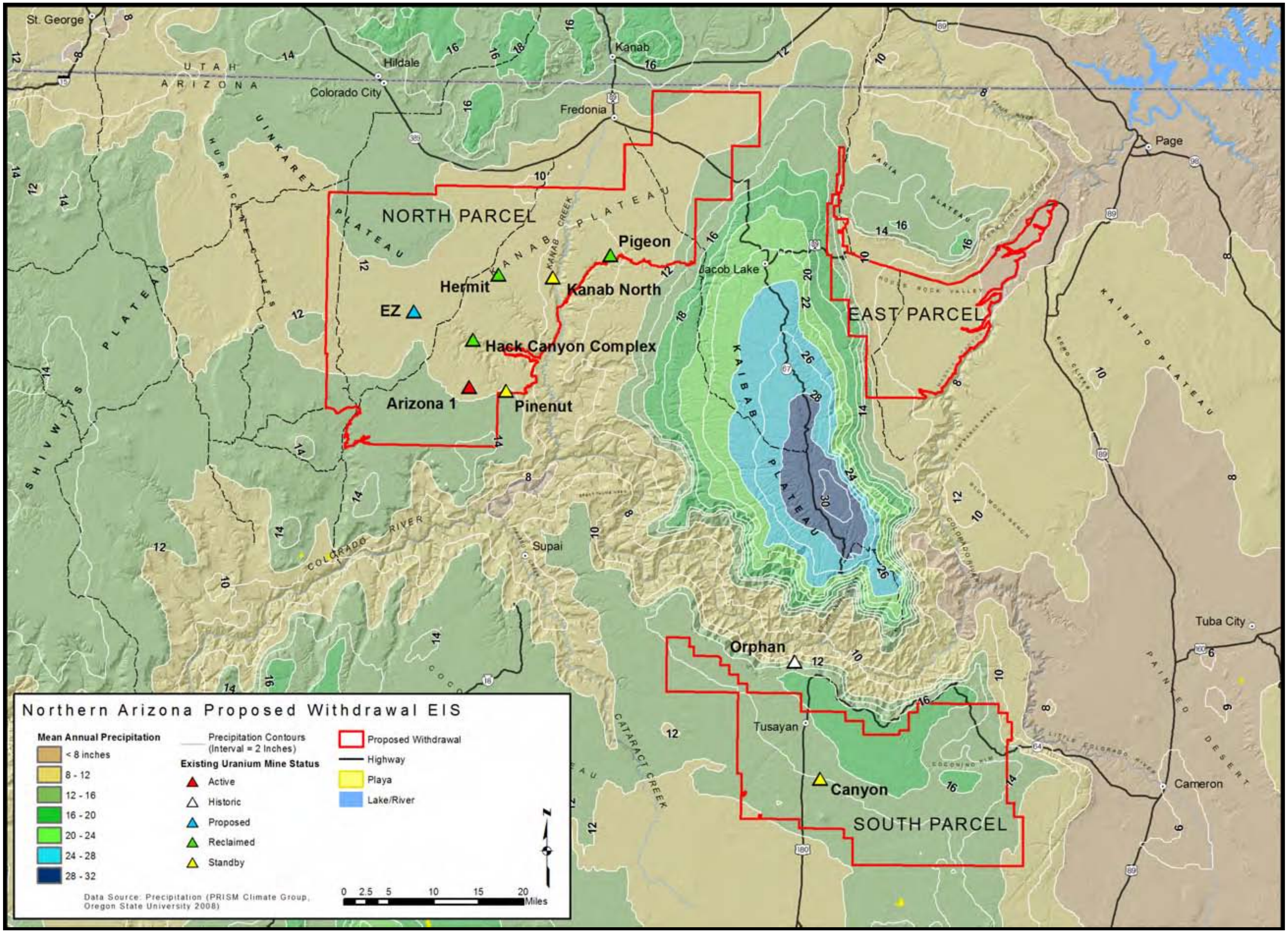


Figure 3.4-10. Mean annual precipitation, 1971 through 2000.

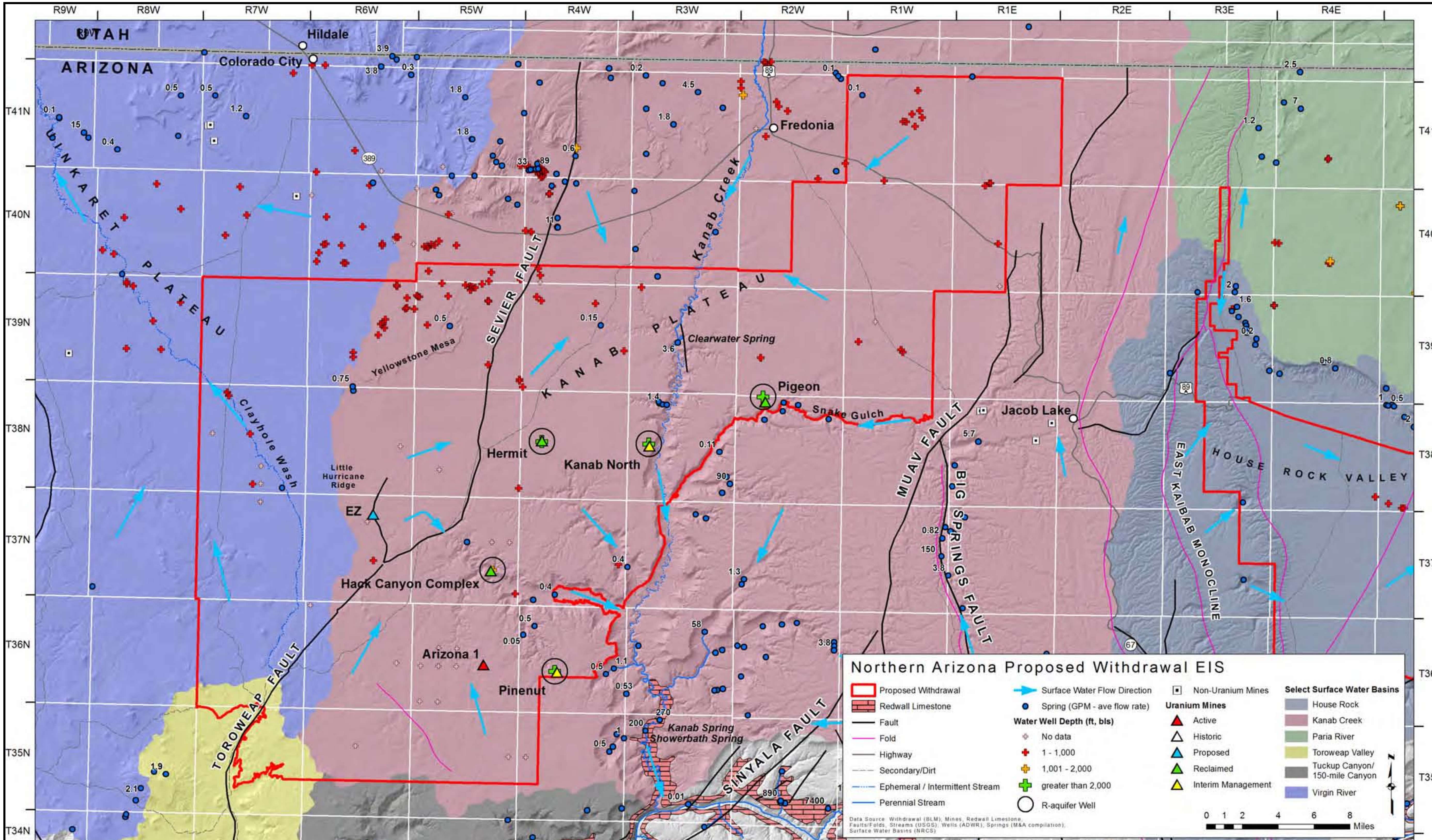


Figure 3.4-11. Hydrologic features for North Parcel.

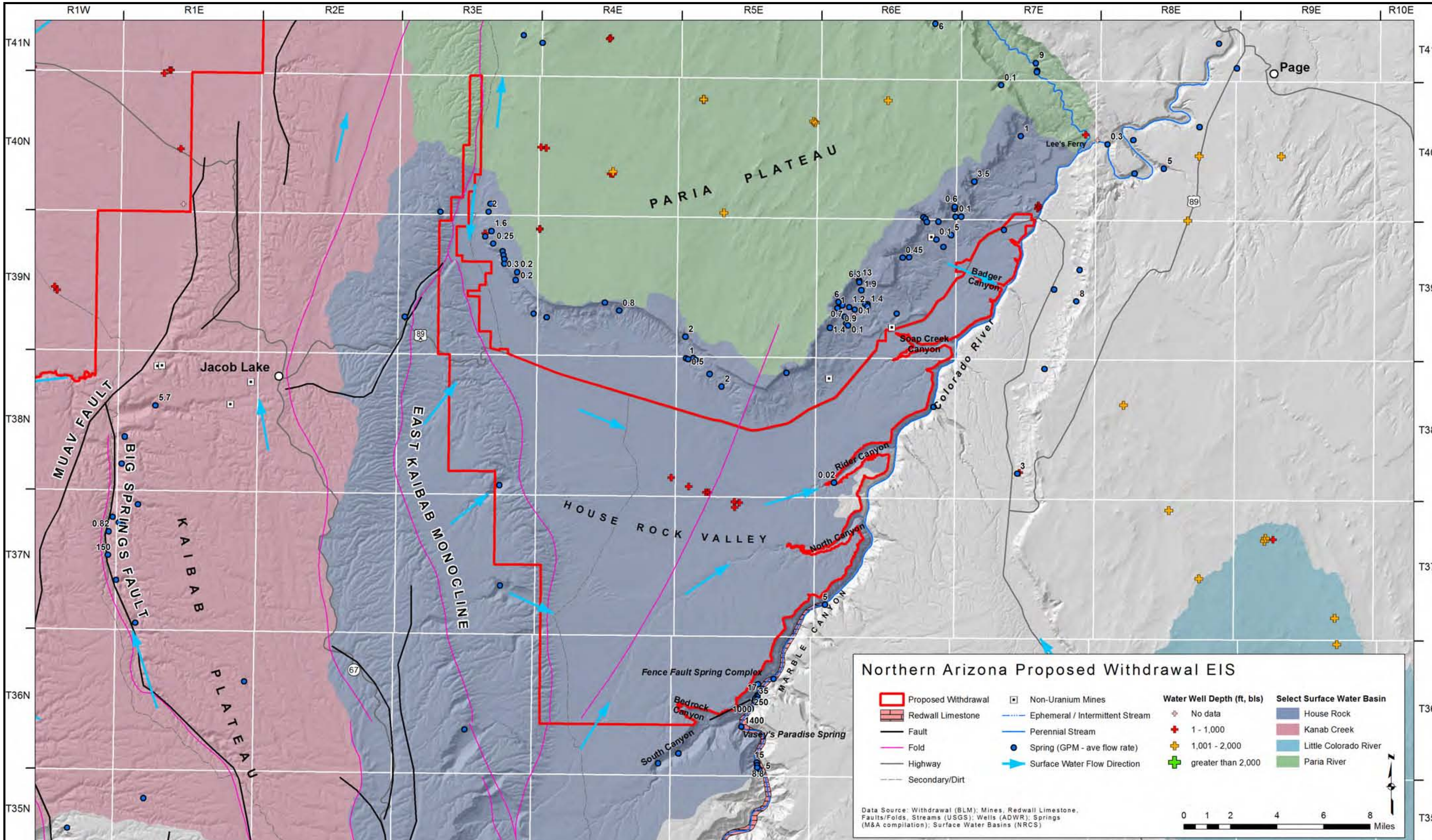


Figure 3.4-12. Hydrologic features for East Parcel.

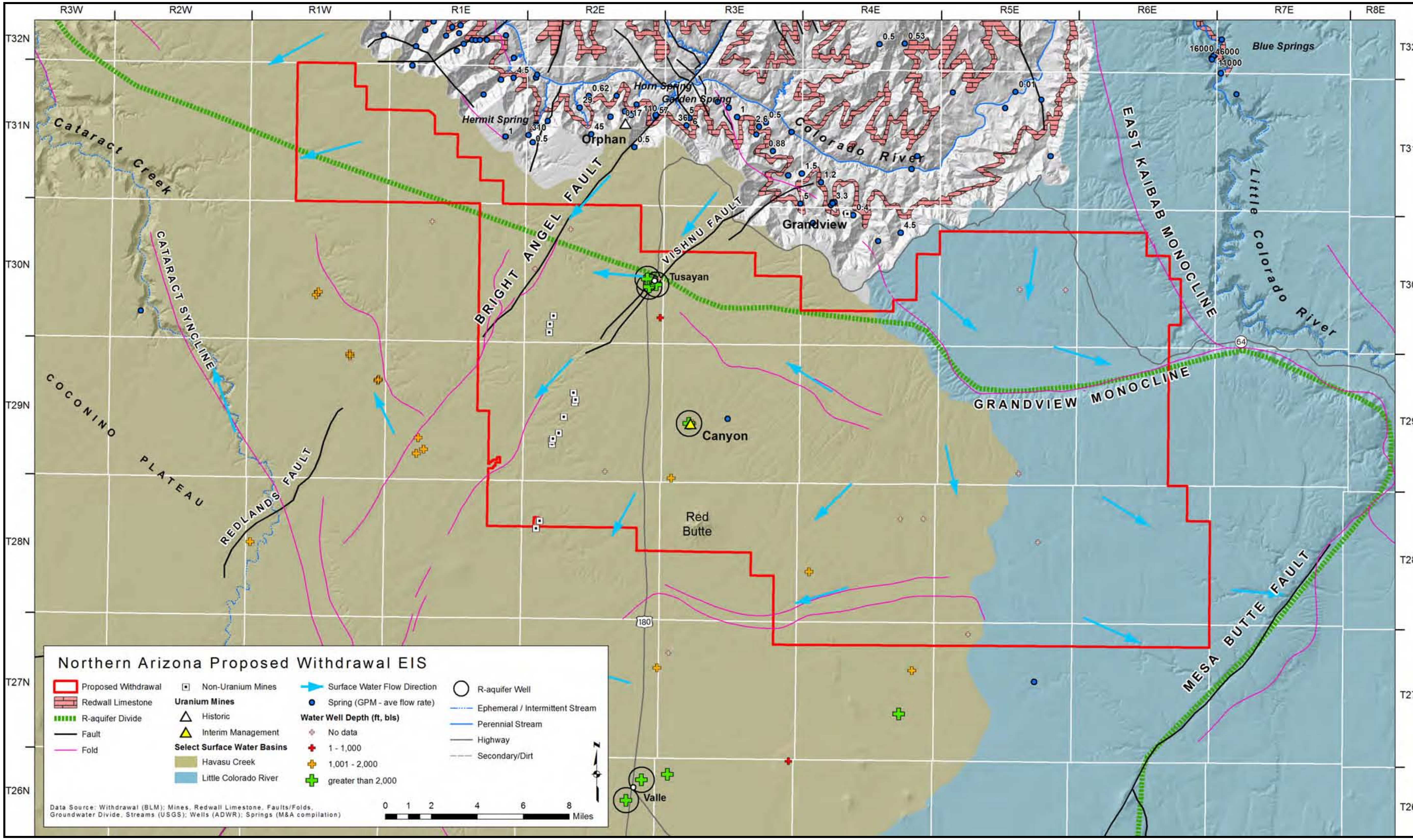


Figure 3.4-13. Hydrologic features for South Parcel.

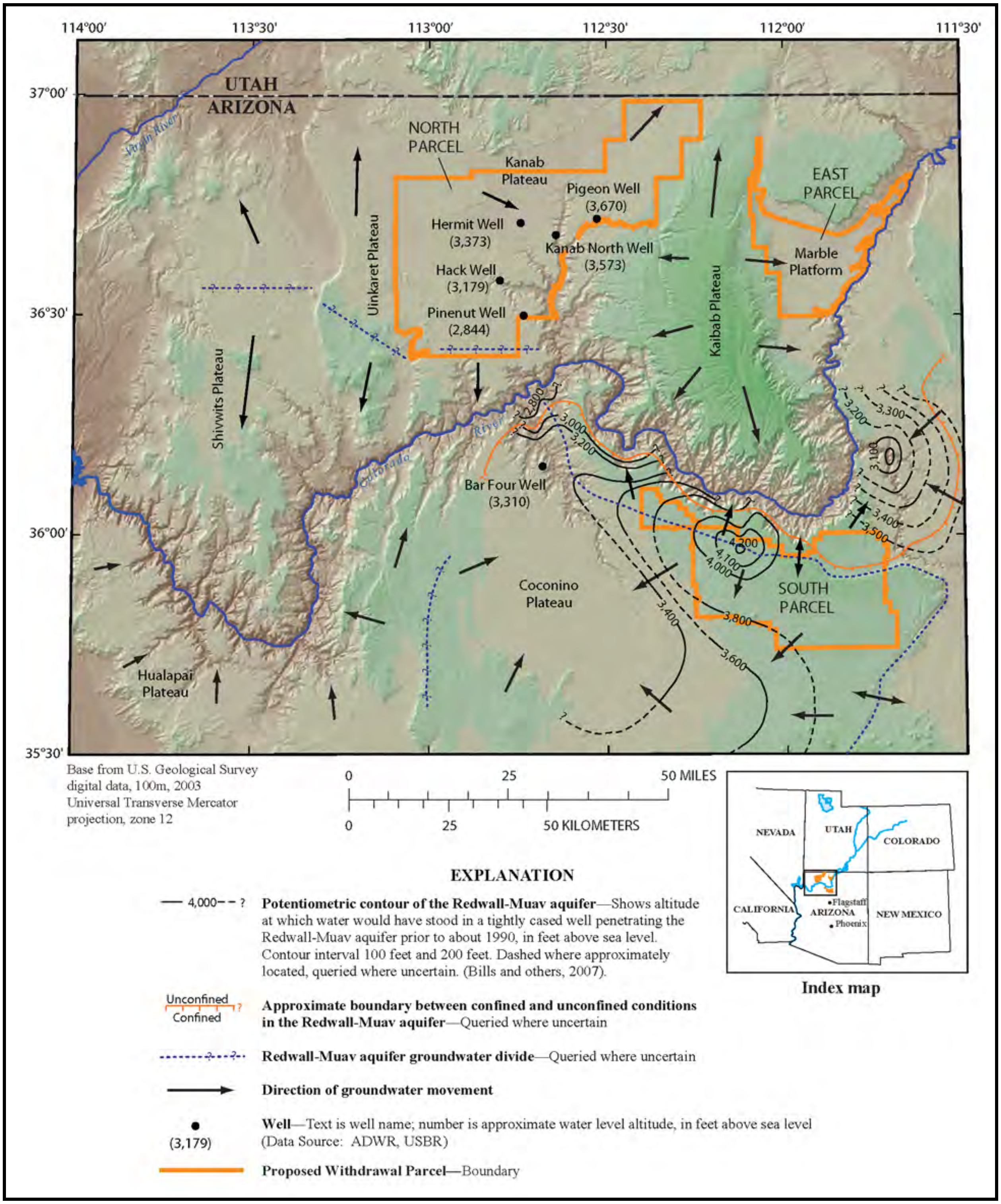


Figure 3.4-14. General direction of groundwater movement in the regional aquifer in the water resources study area (modified from Bills et al. 2010).

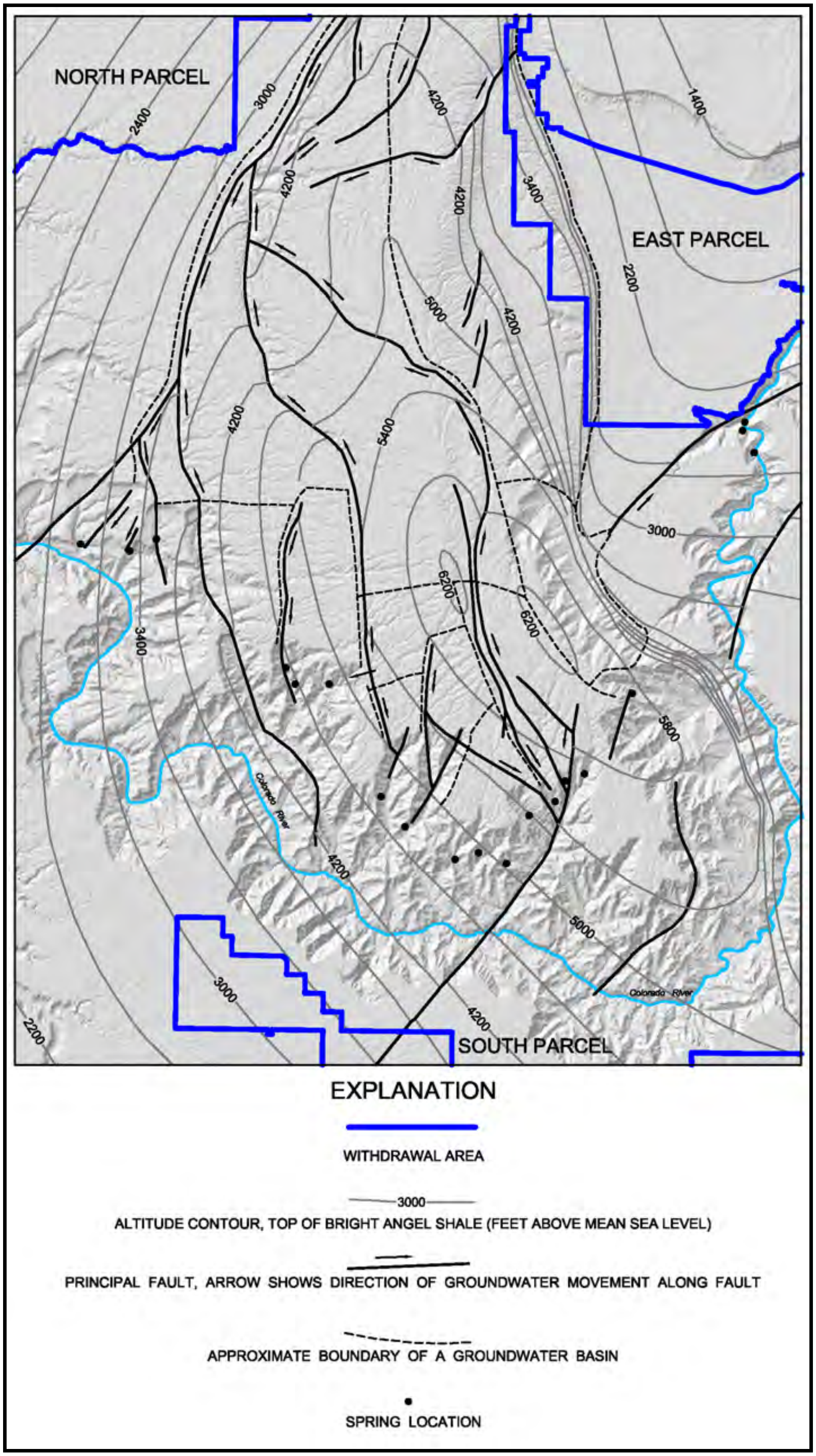


Figure 3.4-15. Direction of groundwater movement in the Kaibab Plateau region (modified from Huntoon 1974).

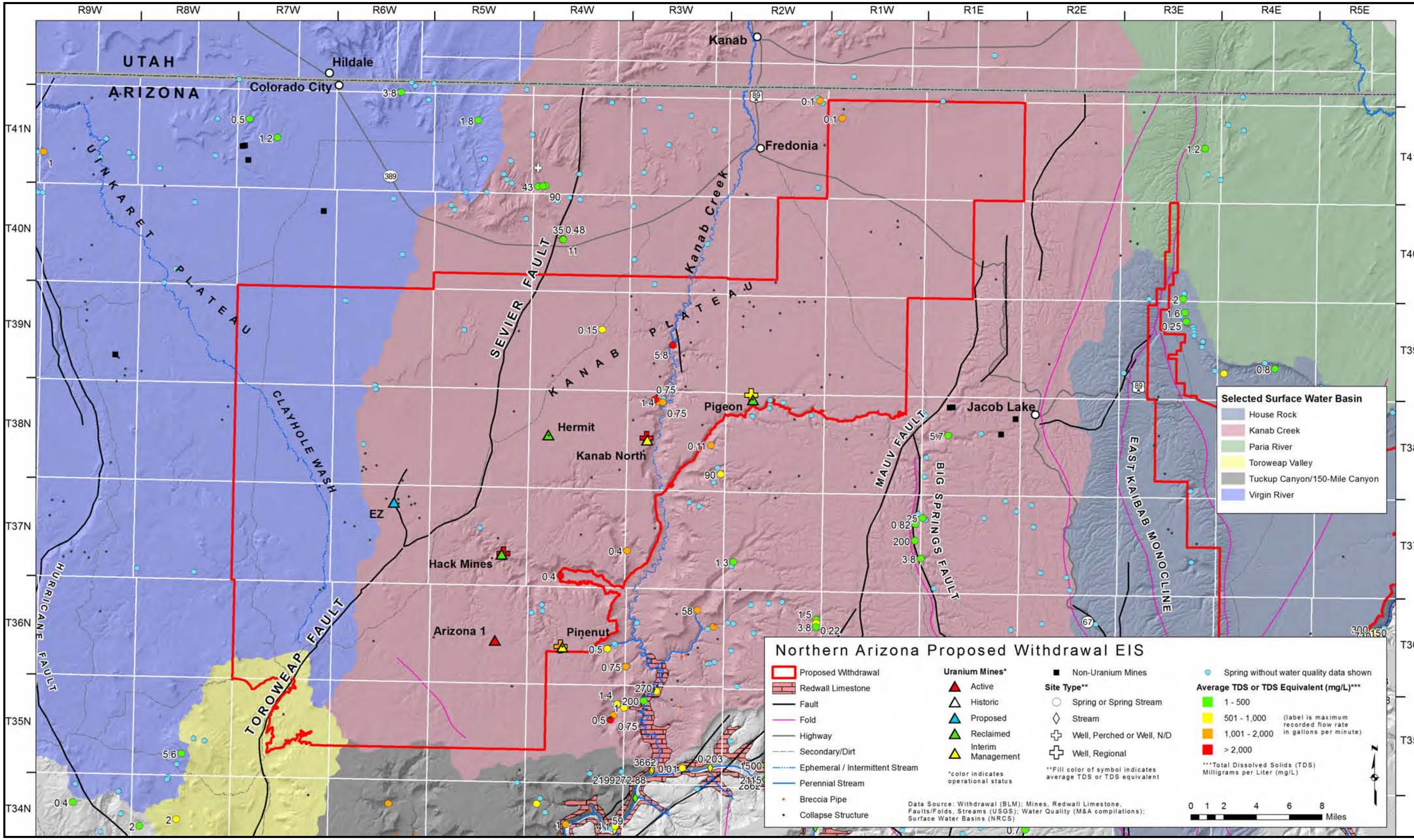


Figure 3.4-16a. Total dissolved solids concentration and discharge of springs, streams, and wells for the North Parcel and vicinity.

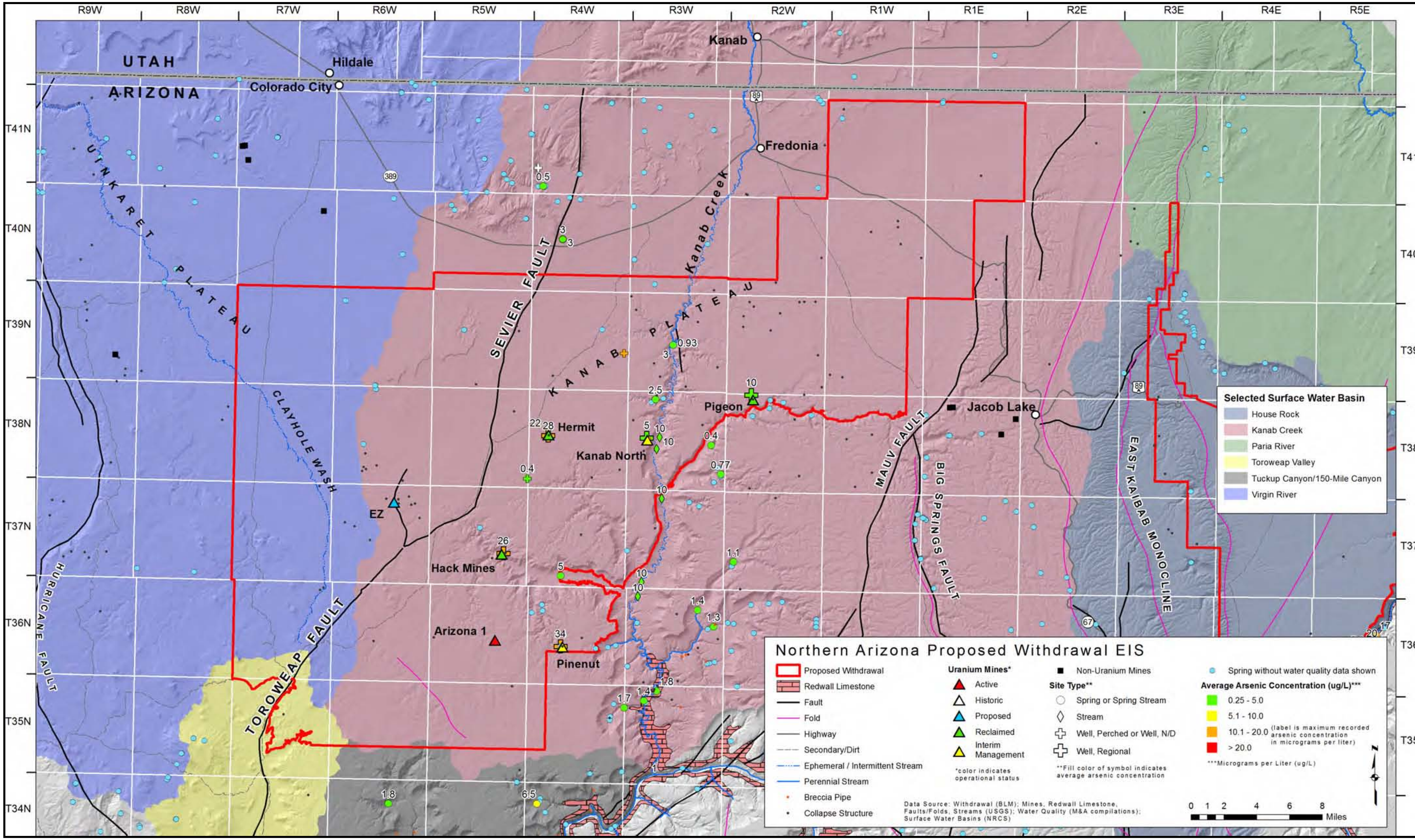


Figure 3.4-16b. Arsenic concentration of springs, streams, and wells for the North Parcel and vicinity.

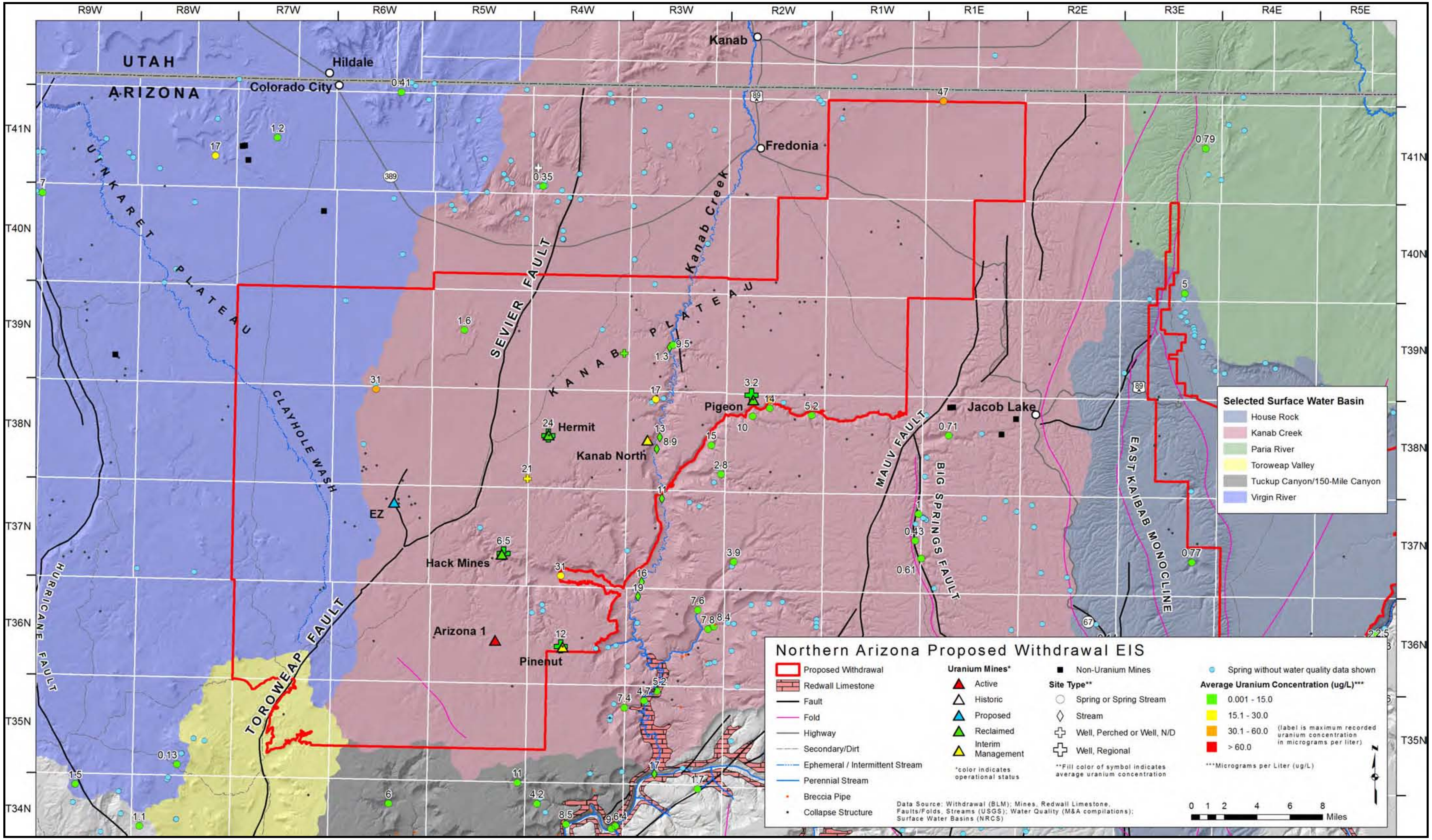


Figure 3.4-16c. Uranium concentration of springs, streams, and wells for the North Parcel and vicinity.

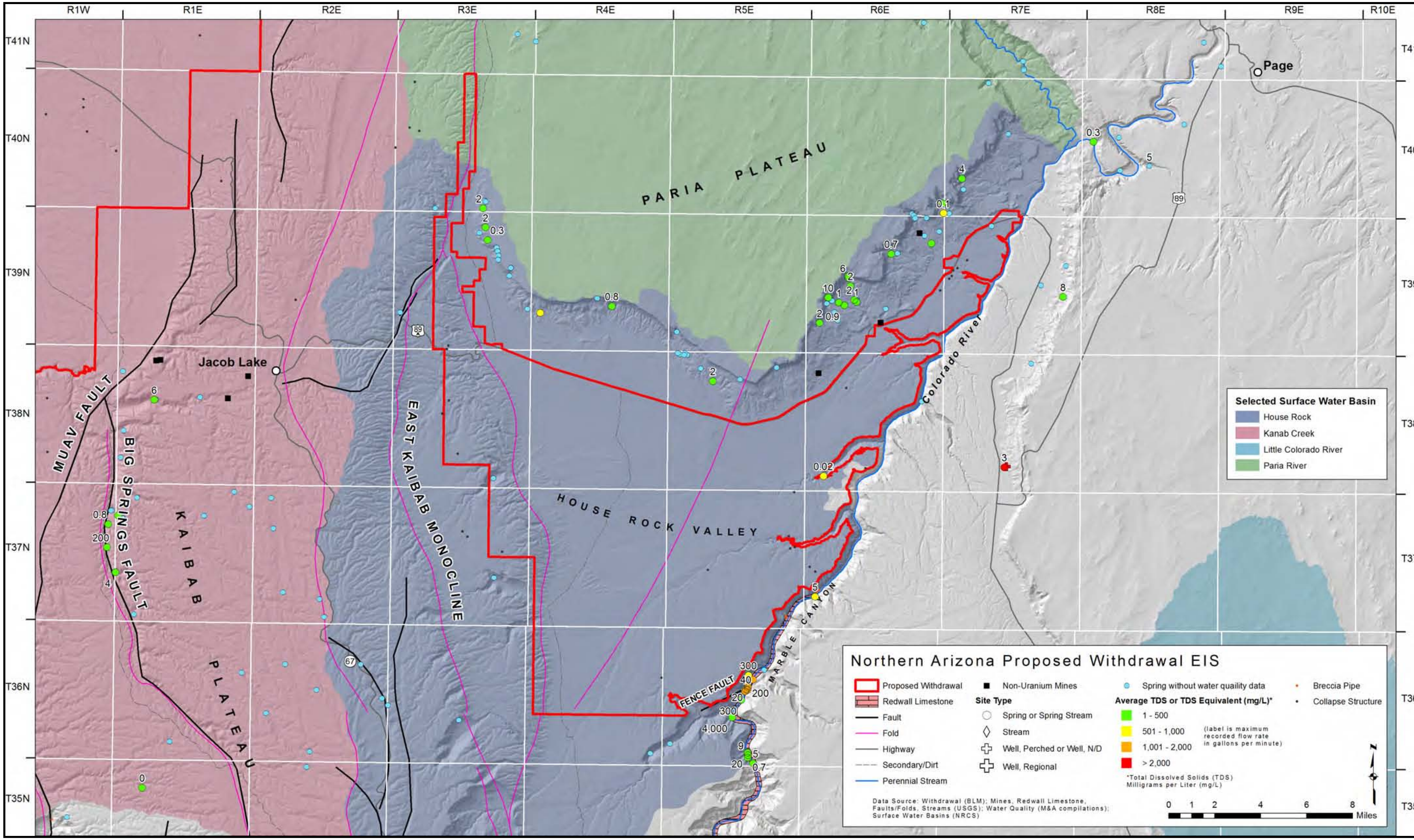


Figure 3.4-17a. Total dissolved solids concentration and discharge of springs, streams, and wells for the East Parcel and vicinity.

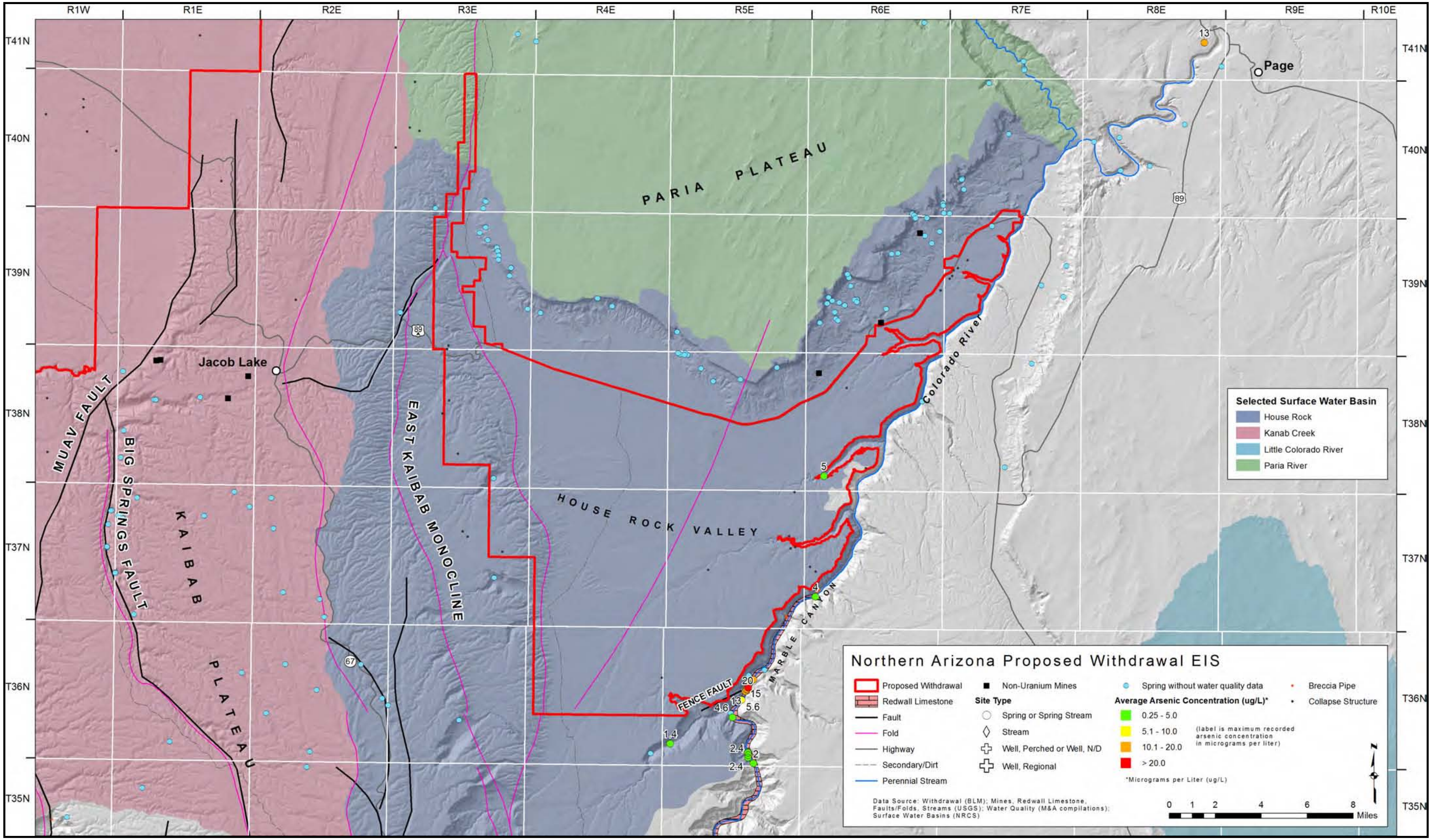


Figure 3.4-17b. Arsenic concentration of springs, streams, and wells for the East Parcel and vicinity.

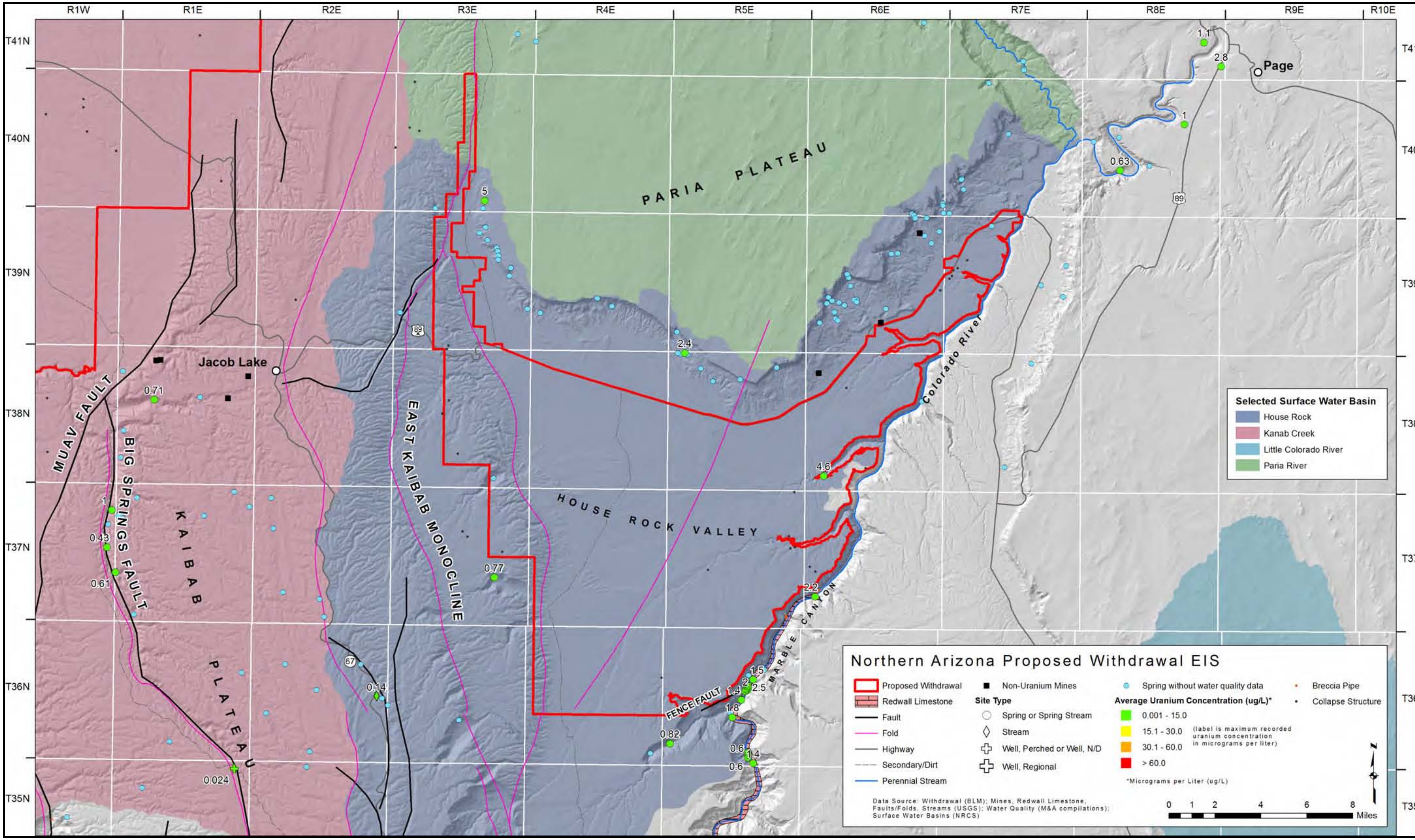


Figure 3.4-17c. Uranium concentration of springs, streams, and wells for the East Parcel and vicinity.

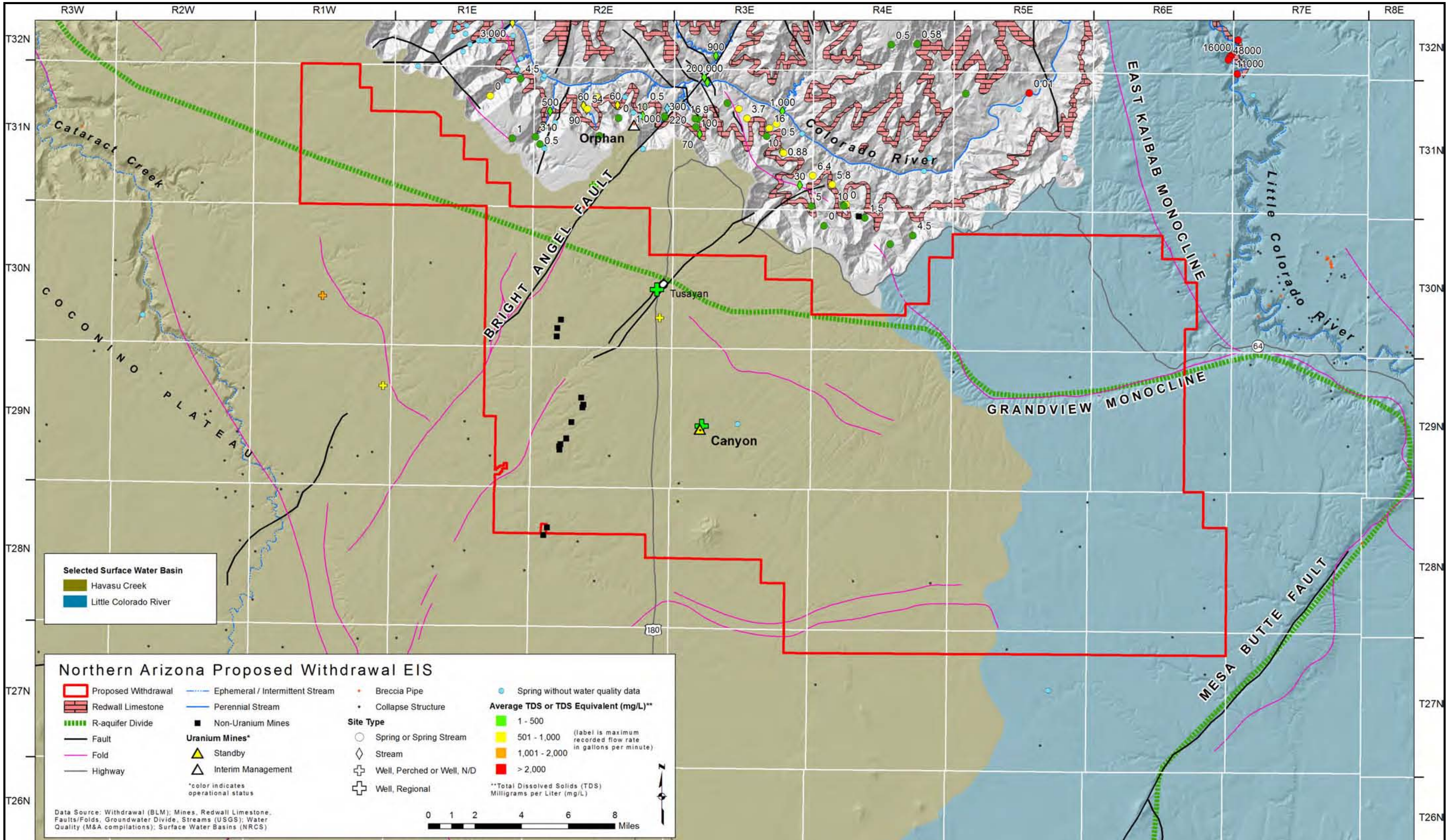


Figure 3.4-18a. Total dissolved solids concentration and discharge of springs, streams, and wells for the South Parcel and vicinity.

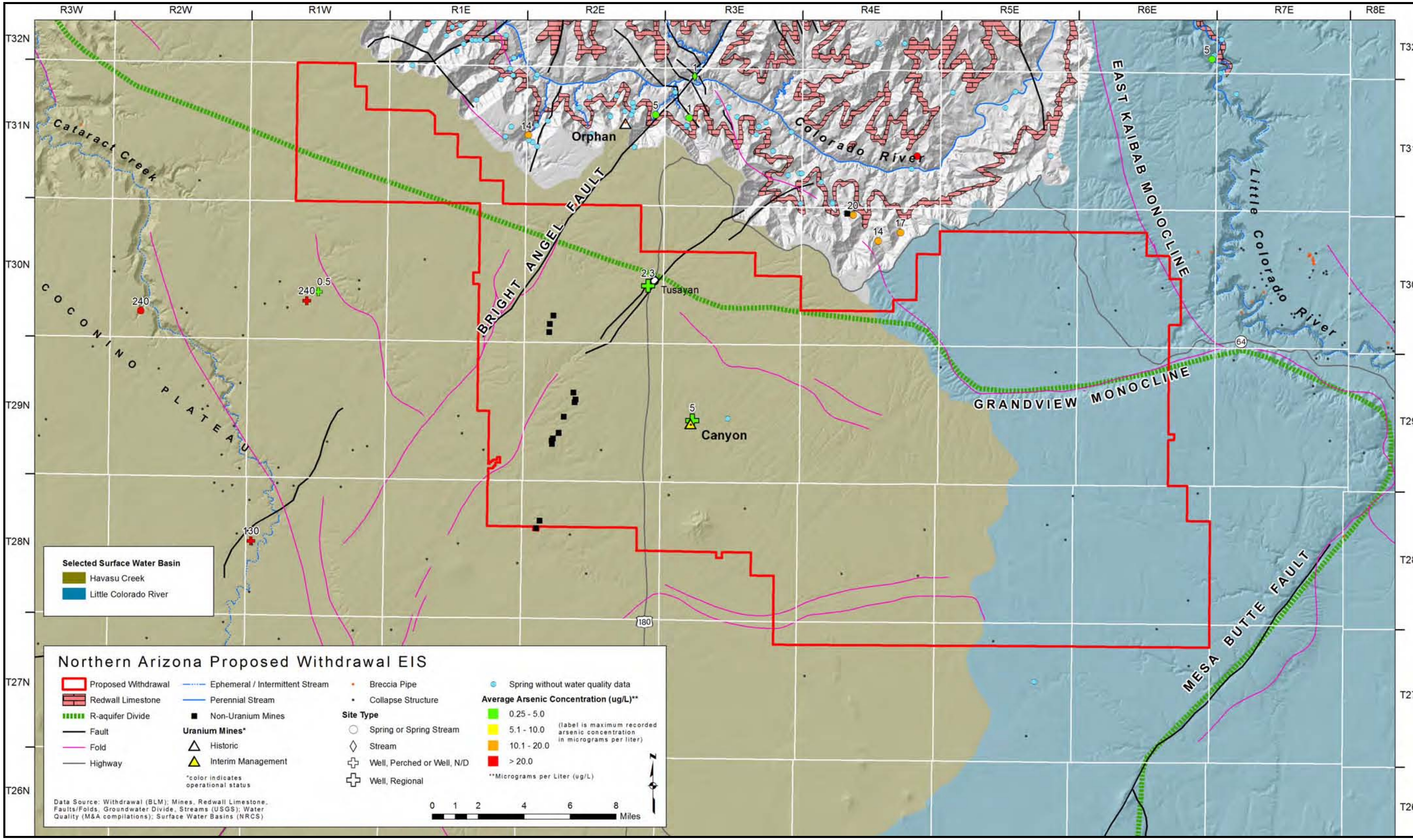


Figure 3.4-18b. Arsenic concentration of springs, streams, and wells for the South Parcel and vicinity.

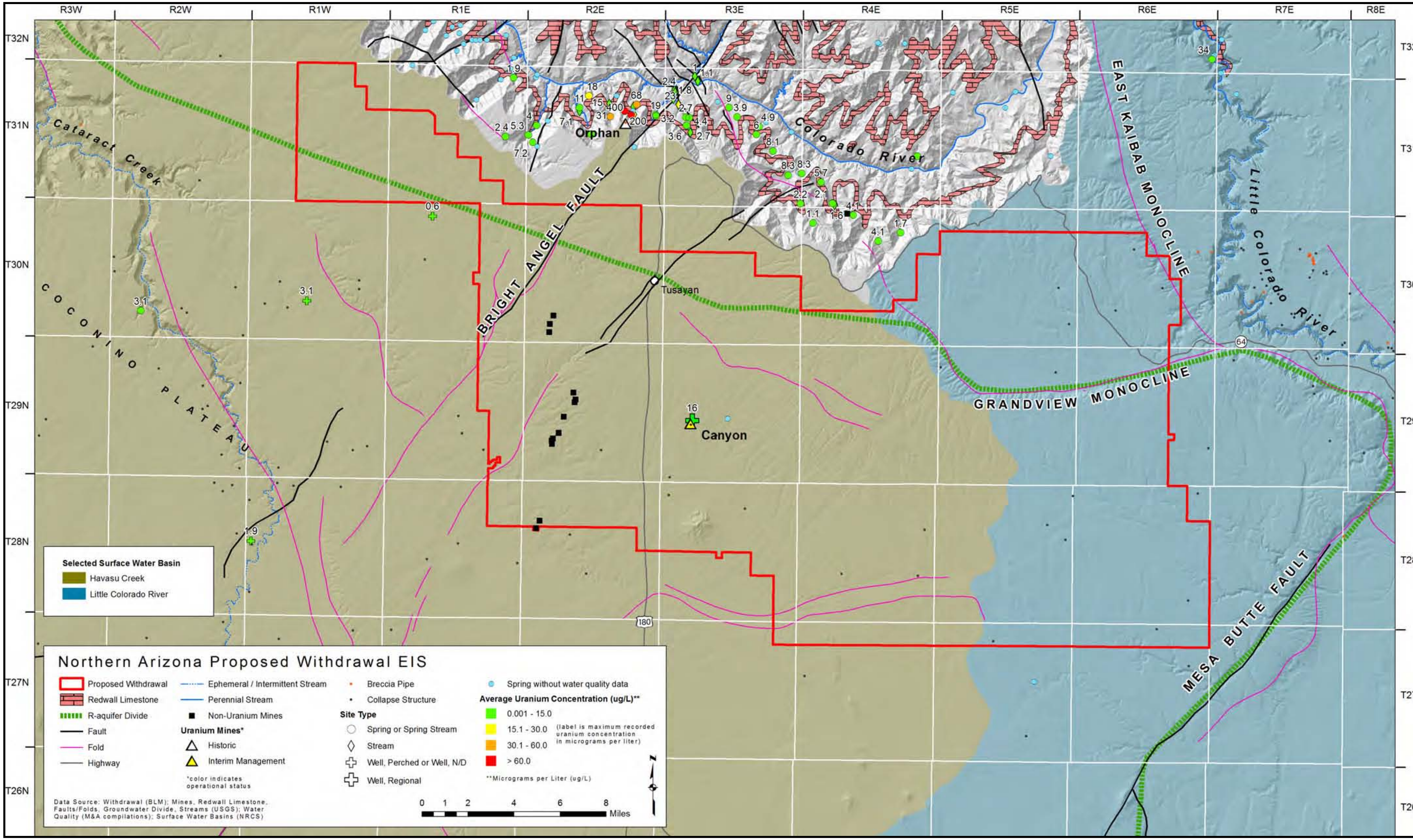


Figure 3.4-18c. Uranium concentration of springs, streams, and wells for the South Parcel and vicinity.

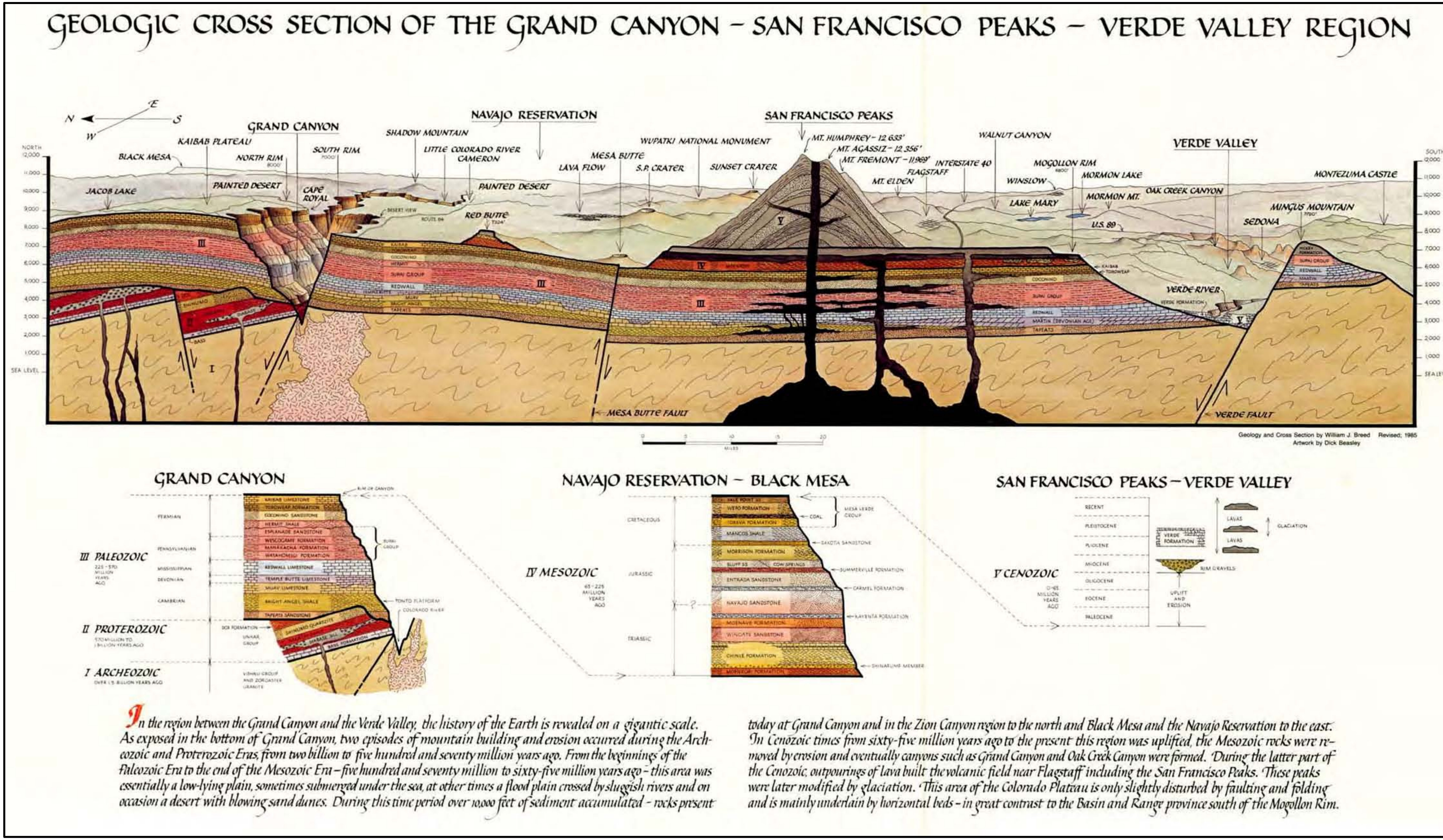
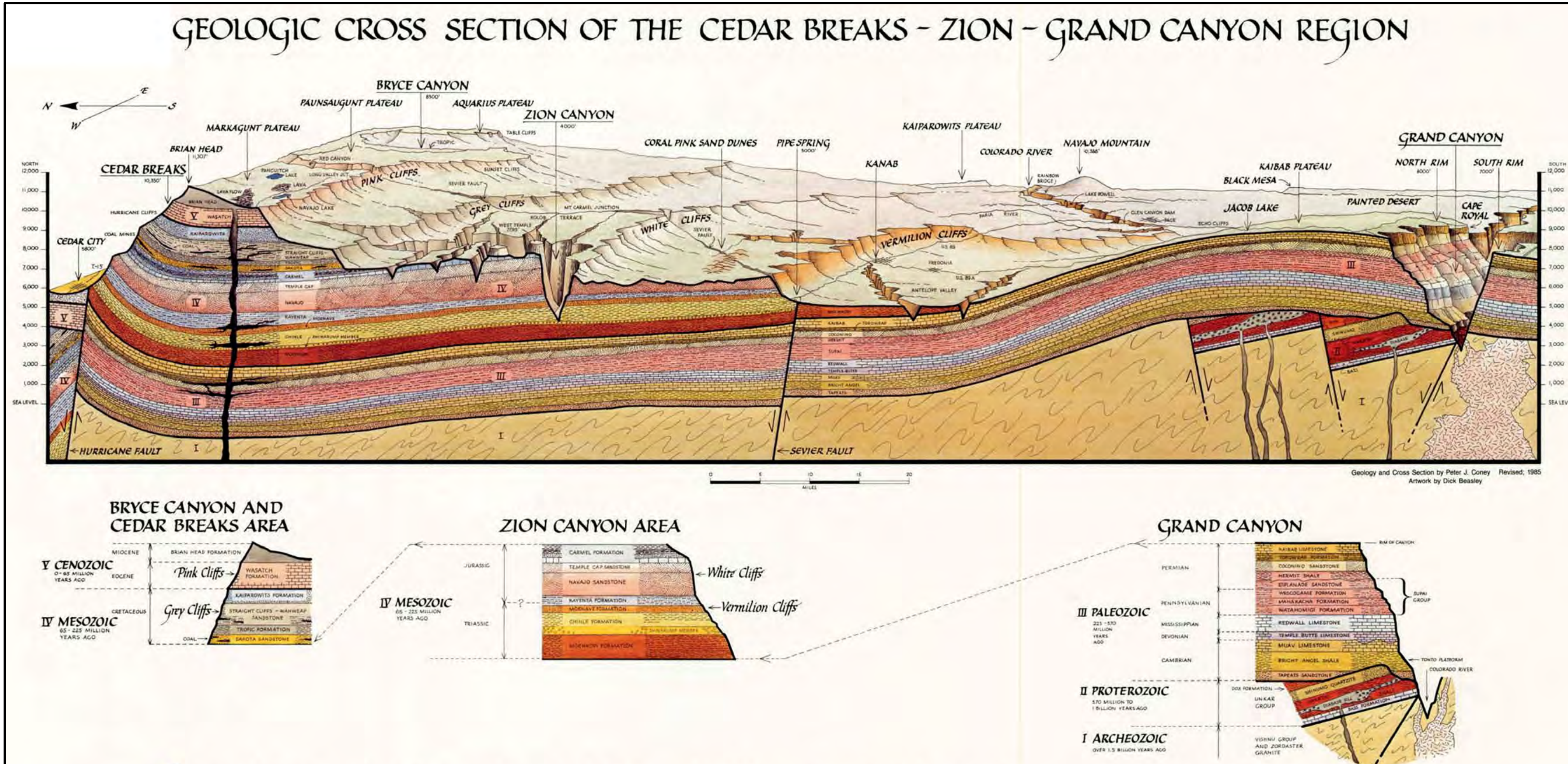


Figure 3.4-3. Conceptual geological section of the Grand Canyon–San Francisco Peaks–Verde Valley region (from Zion Natural History Association 1975a).



In this region the forces of erosion have laid bare over one billion five hundred million years of the Earth's history. The oldest rocks, those of the Archeozoic, Proterozoic and Paleozoic Eras are found in the walls of the Grand Canyon, where tracks of early amphibians and reptiles, primitive fish, trilobites, brachiopods and many other fossils have been discovered.

The sheer walls, temples and towers of Zion Canyon are carved from rock layers of the Mesozoic Era. Other exposures of rocks of this era are along the Grey, White and Vermilion Cliffs. In these areas, the rocks contain bones and tracks of now-extinct dinosaurs as well as other reptiles, amphibians, ancient mammals and petrified wood.

Younger rocks of the Cenozoic Era form the pinnacles of Cedar Breaks and Bryce Canyons. Presumably these layers as well as those of Mesozoic Age at Zion once extended over the Grand Canyon Region. However, the relentless wearing of the waters has since stripped these layers back to the north to form the celebrated "Great Rock Stairway" of the Vermilion, White, Grey and Pink Cliffs.

Figure 3.4-4. Conceptual geological section of the Cedar Breaks–Zion–Grand Canyon region (from Zion Natural History Association 1975b).

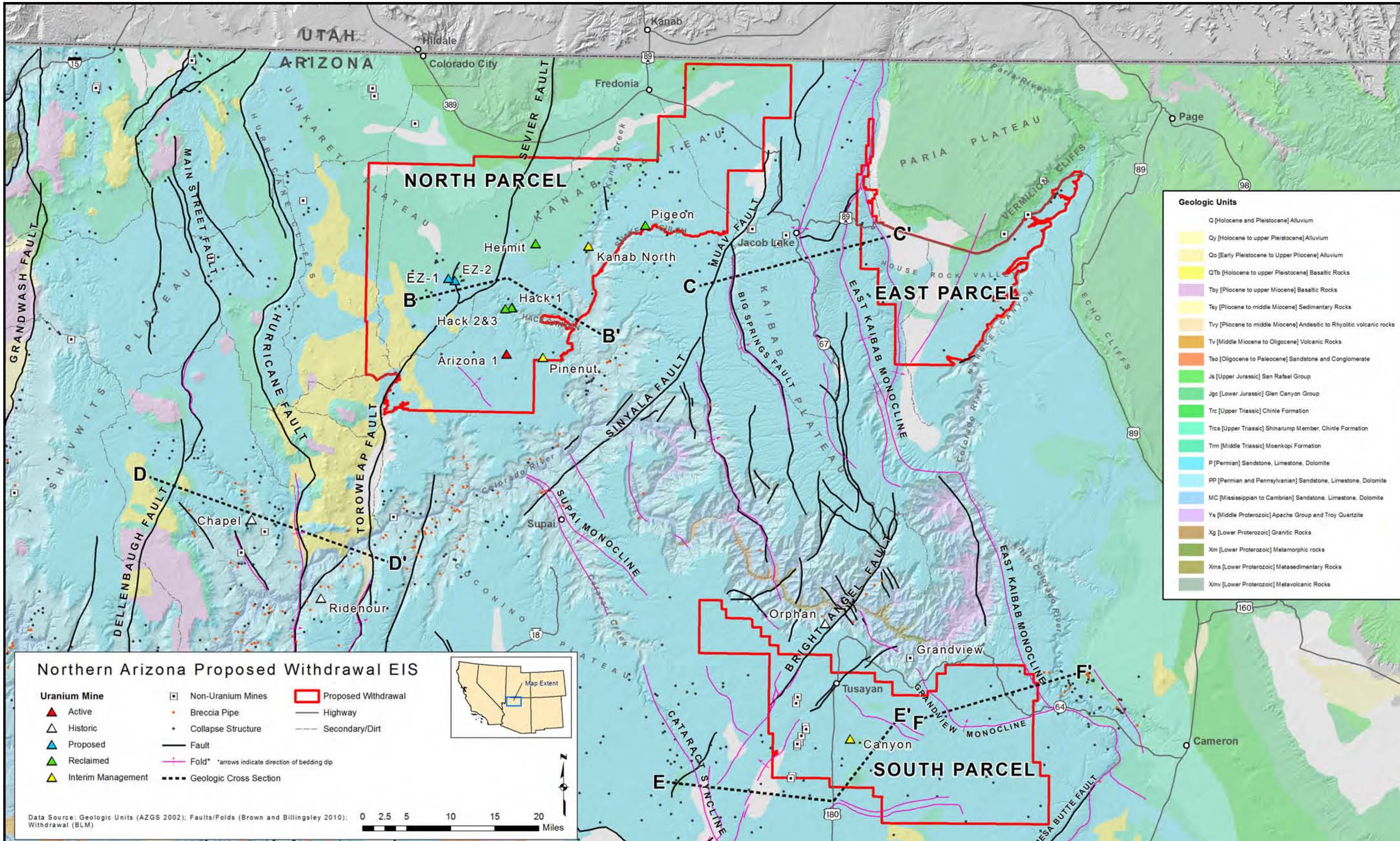


Figure 3.4-5. Geological map for water resources study area.

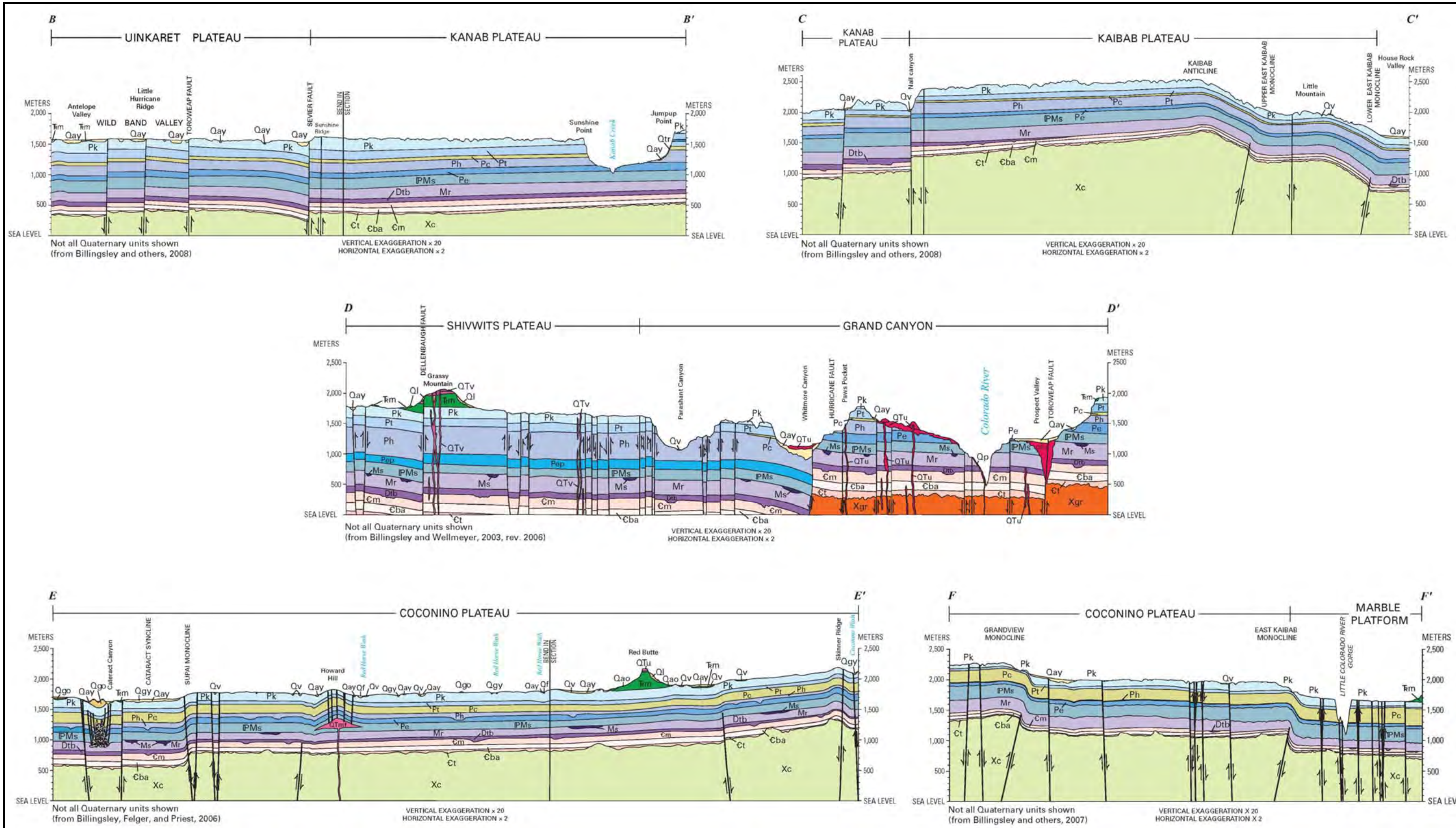


Figure 3.4-6a. Geological sections in water resources study area (modified from Brown and Billingsley 2010).

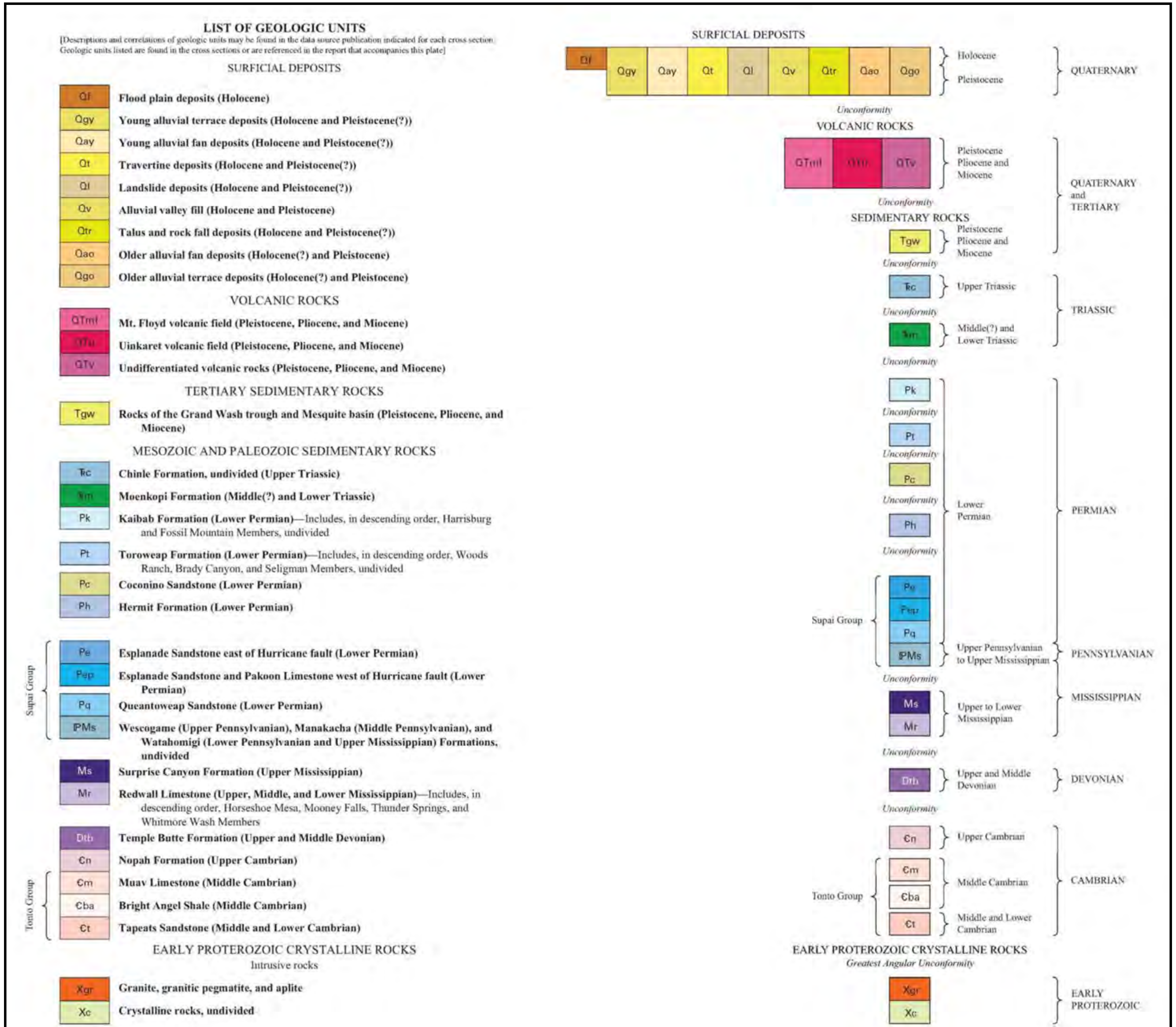


Figure 3.4-6b. Geological sections in water resources study area (modified from Brown and Billingsley 2010).

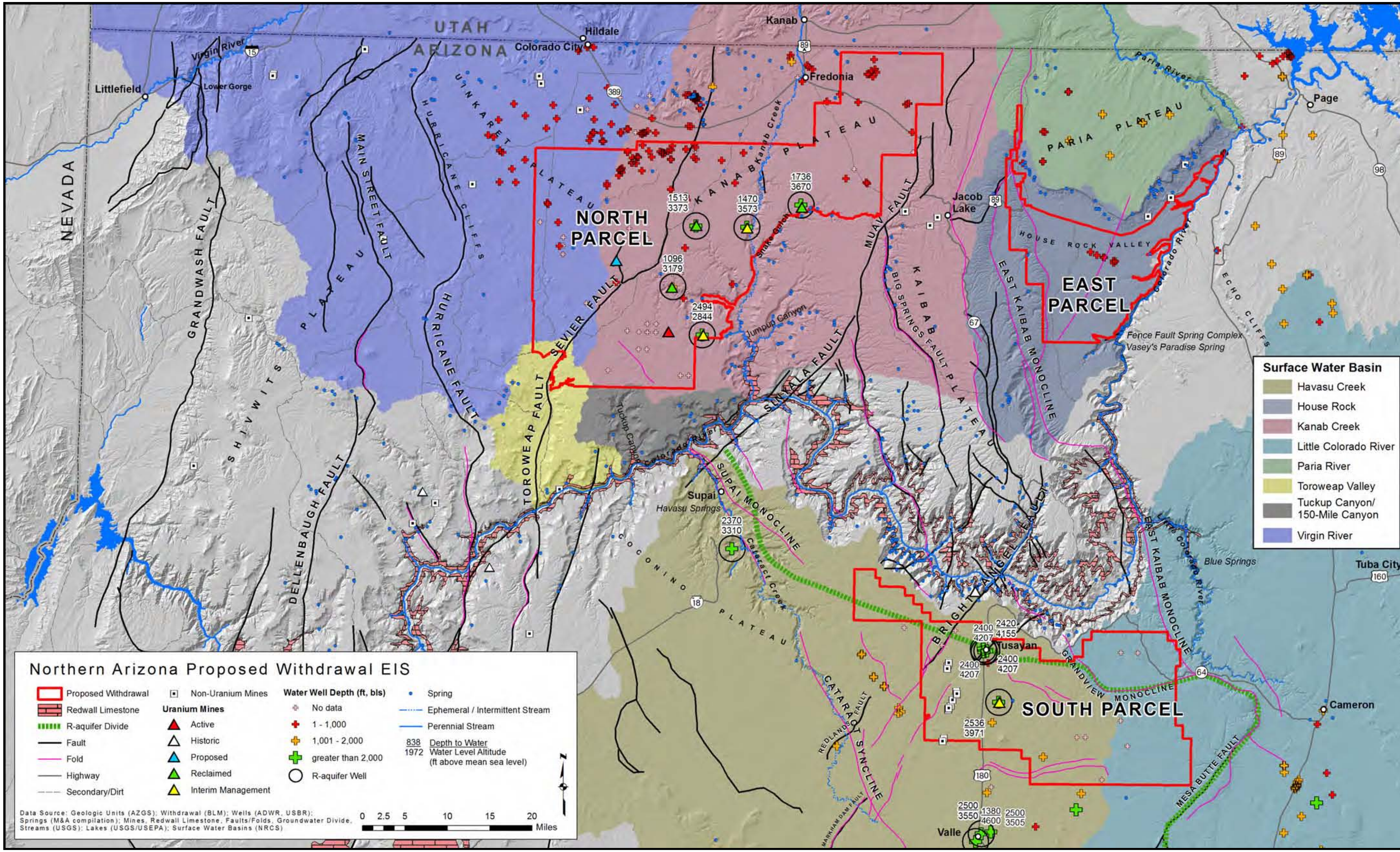


Figure 3.4-9. Hydrologic features for water resources study area.

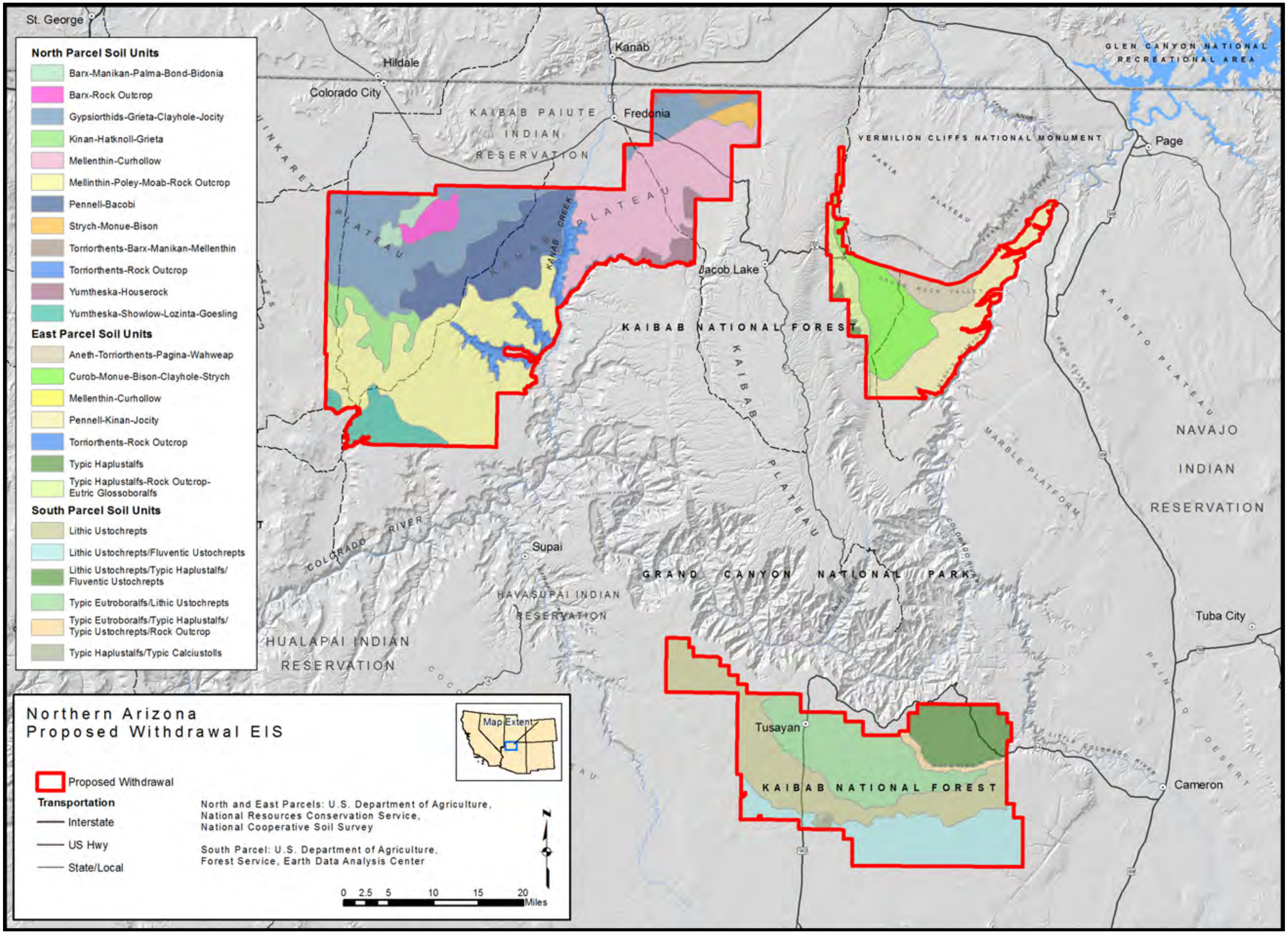


Figure 3.5-1. General soil survey.

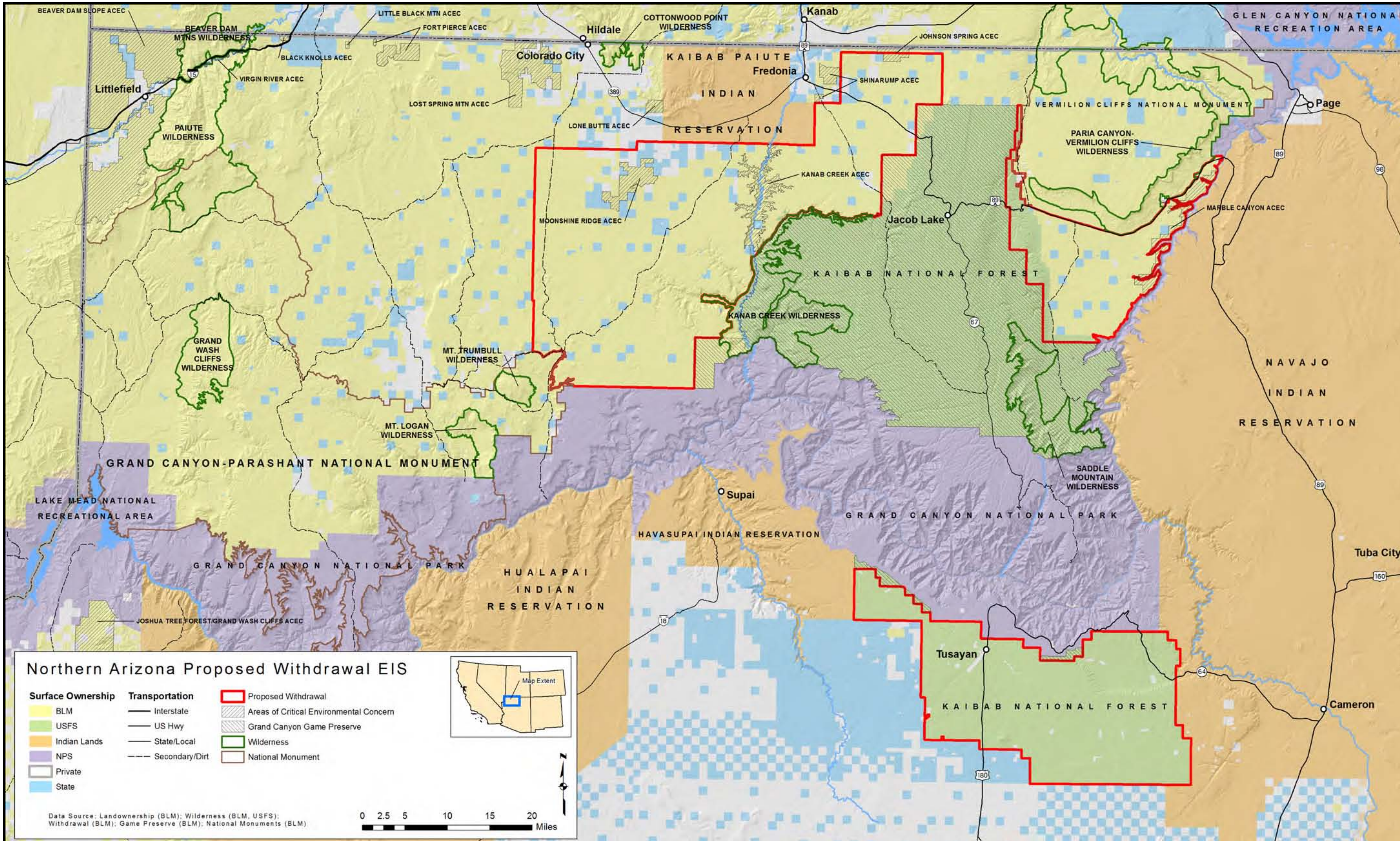


Figure 3.6-1. Proposed withdrawal area and Areas of Critical Environmental Concern.

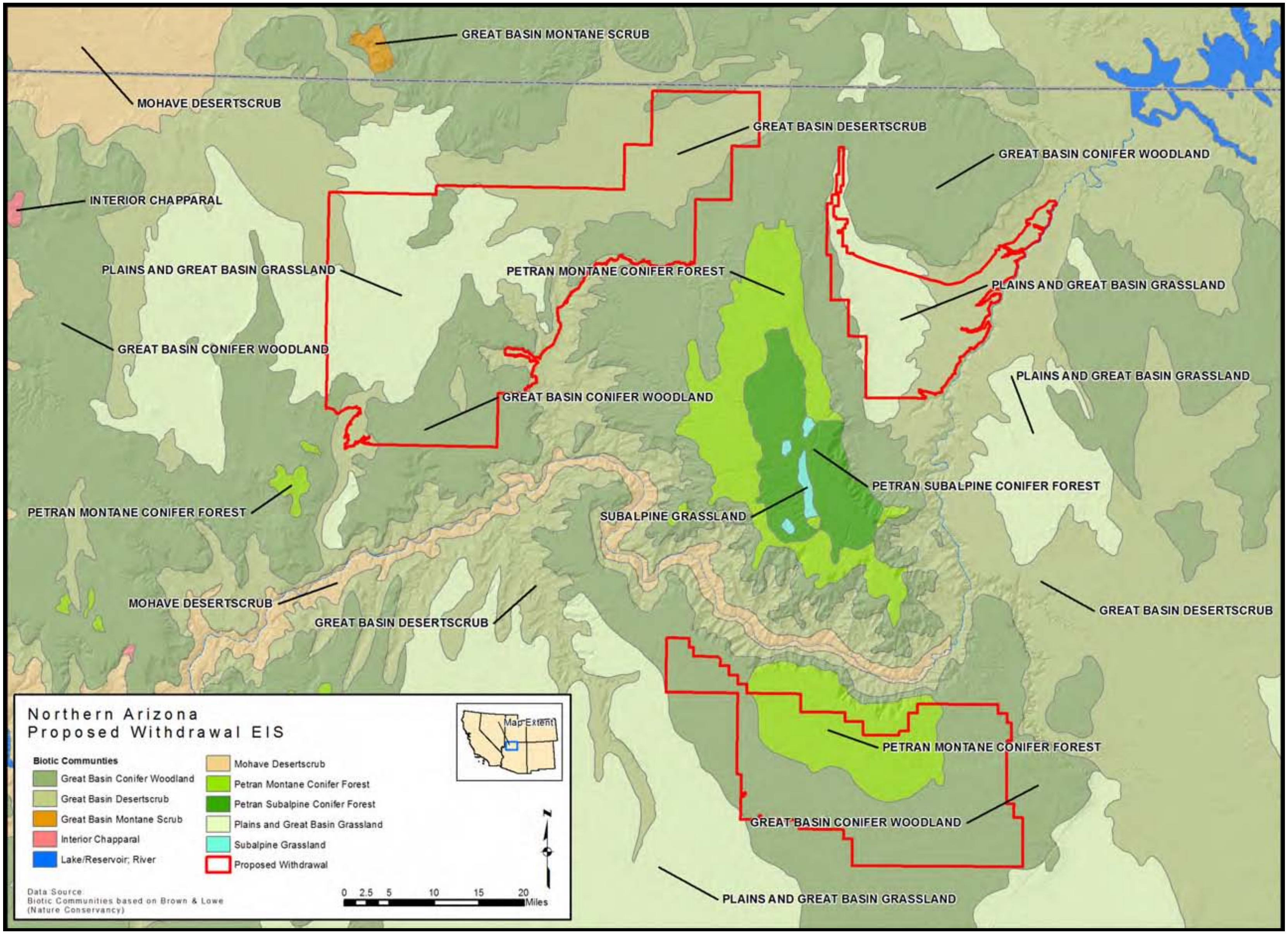


Figure 3.6-2. Vegetation communities (from Brown and Lowe 1980).

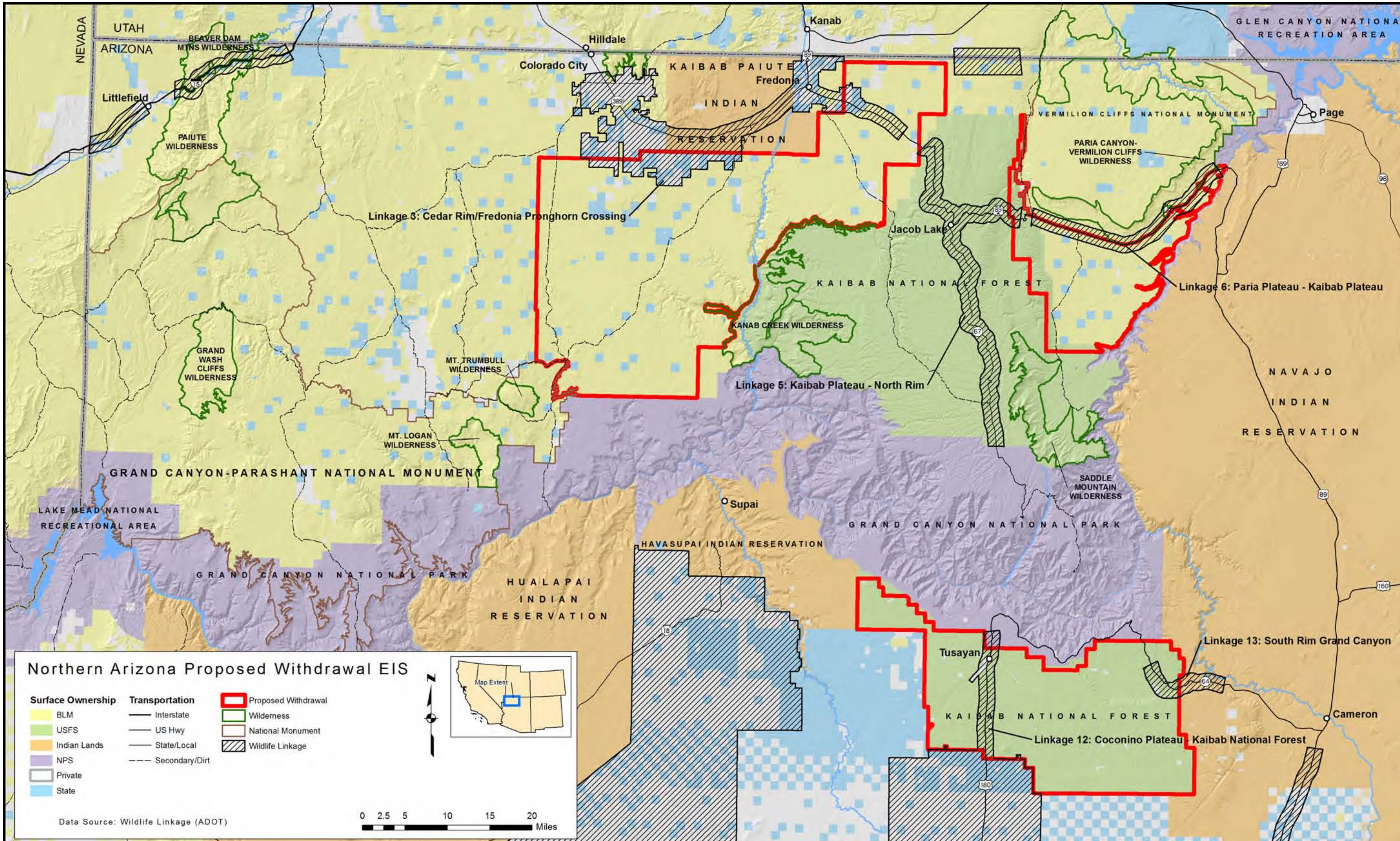


Figure 3.7-1. Wildlife linkages.

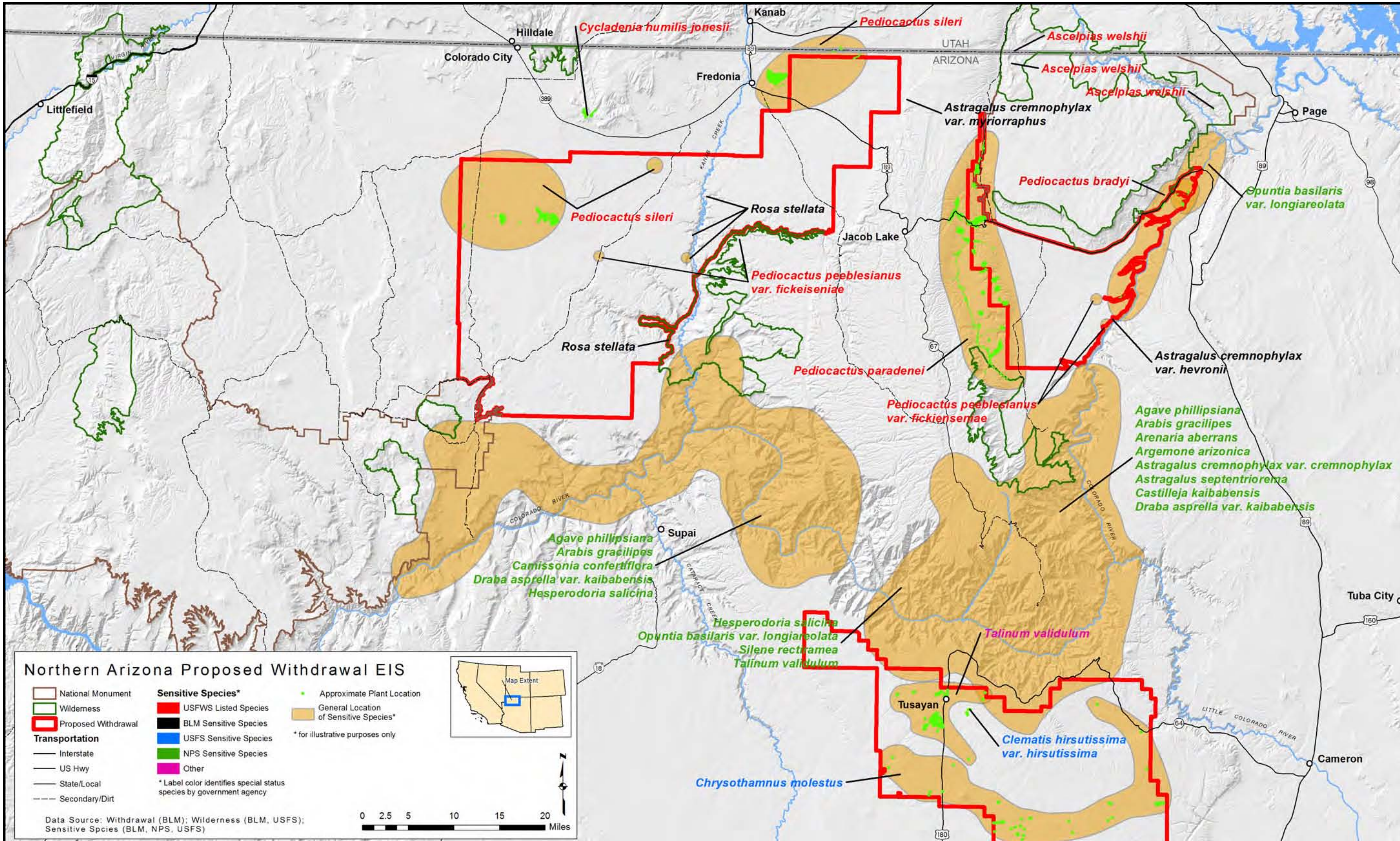


Figure 3.8-1. Special status plants.

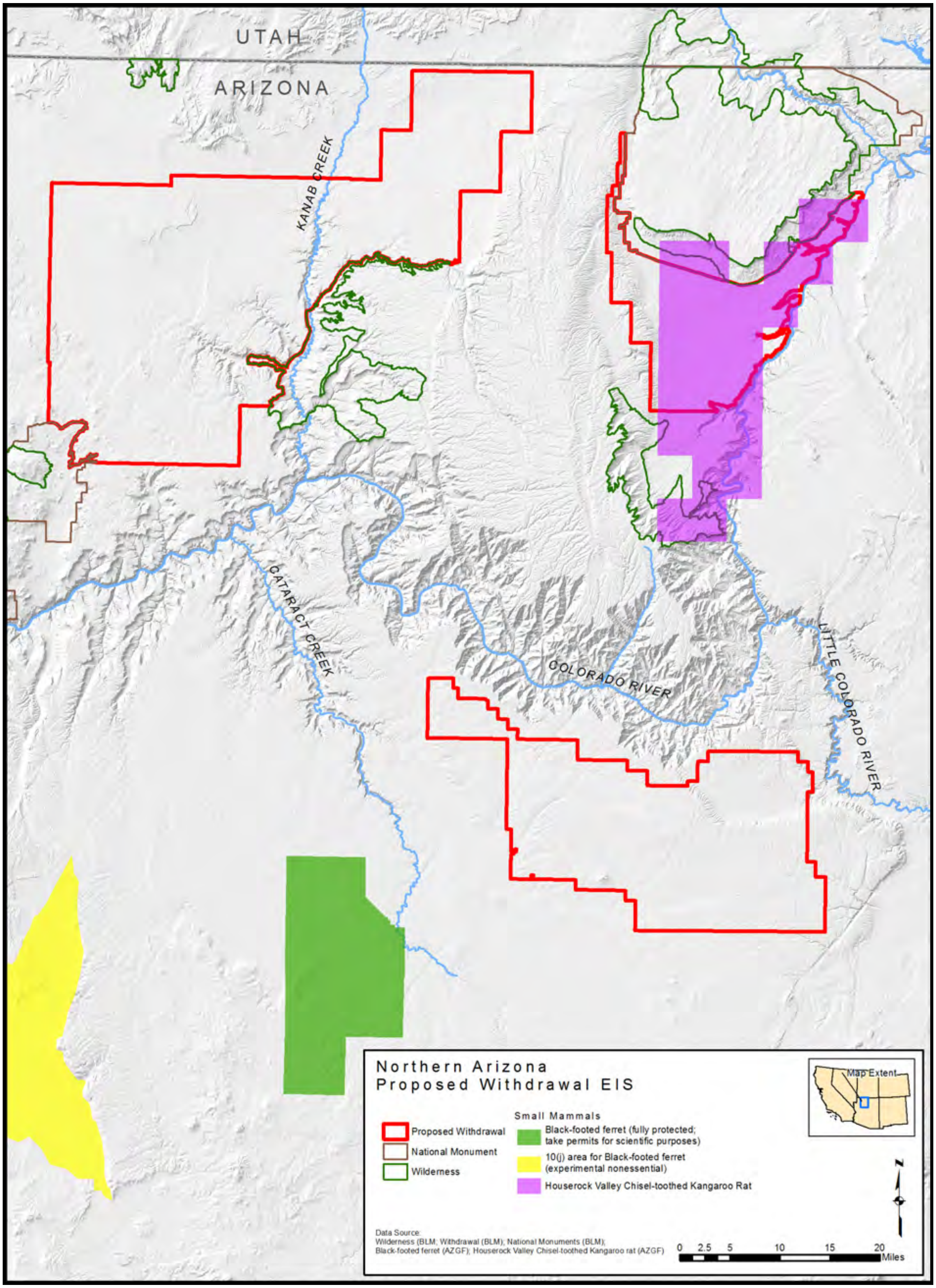


Figure 3.8-2. Black-footed ferret and Houserock Valley chisel-toothed kangaroo rat.

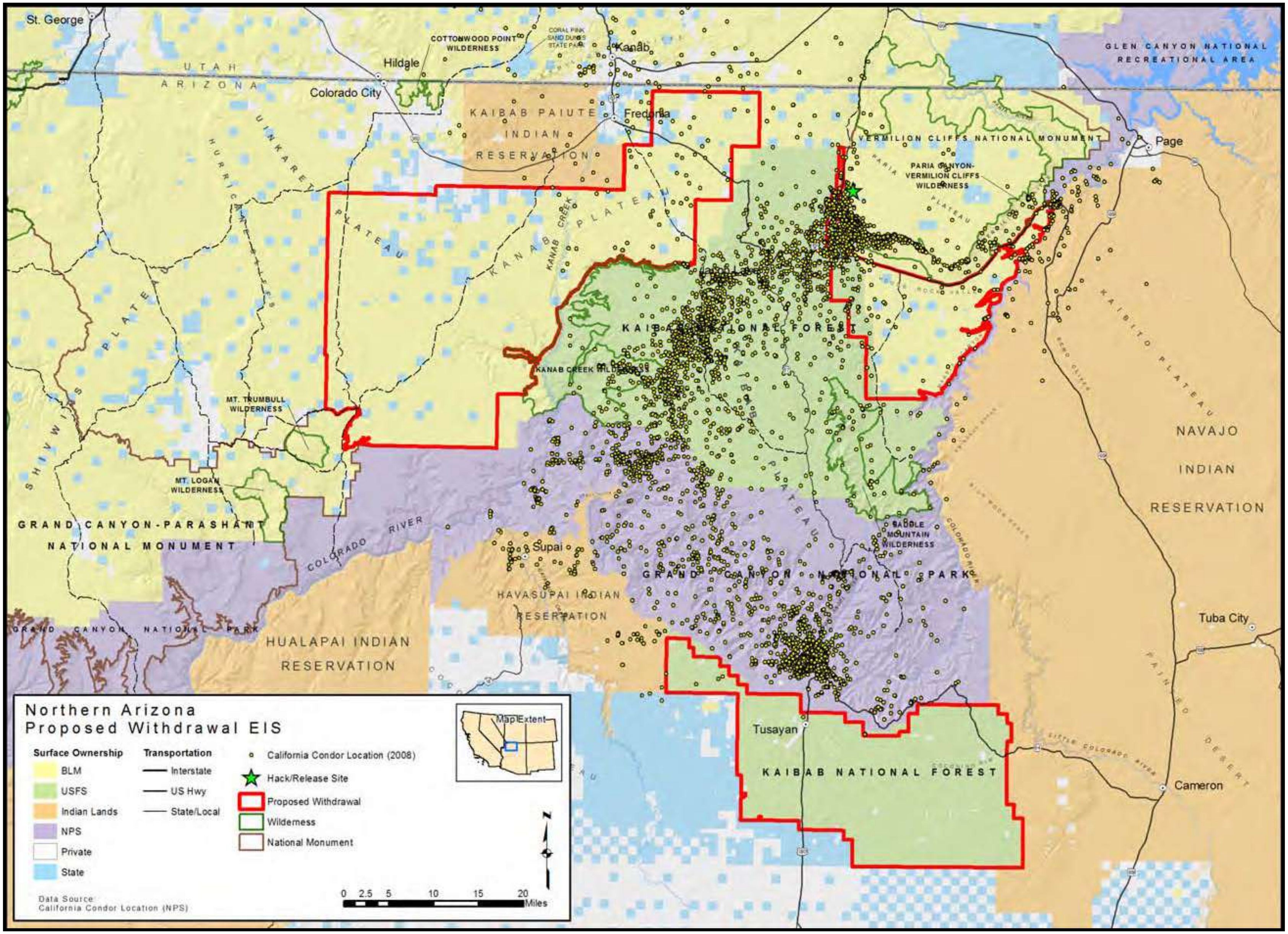


Figure 3.8-3. California condor.

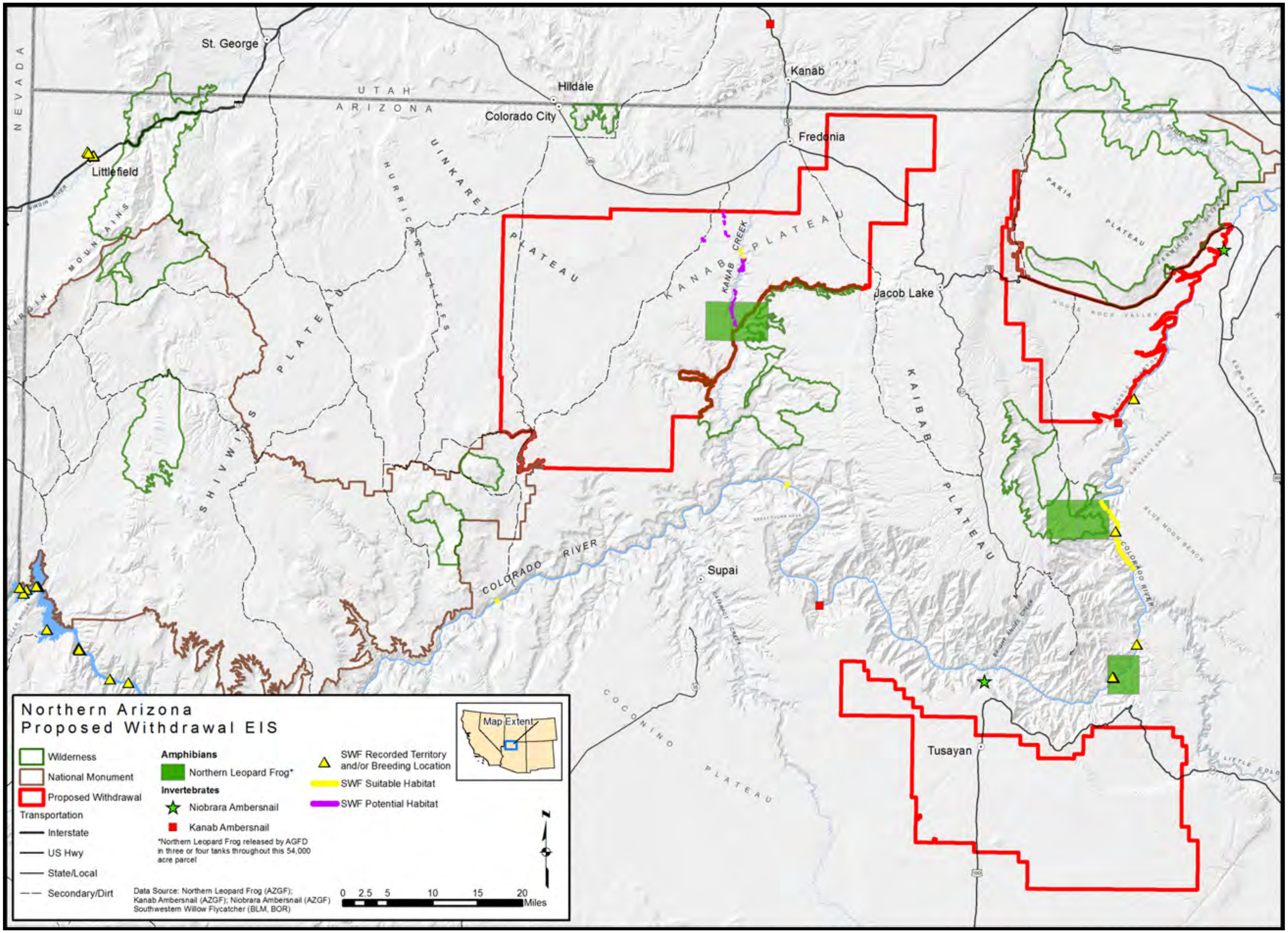


Figure 3.8-4. Ambersnails, northern leopard frog, and southwestern willow flycatcher.

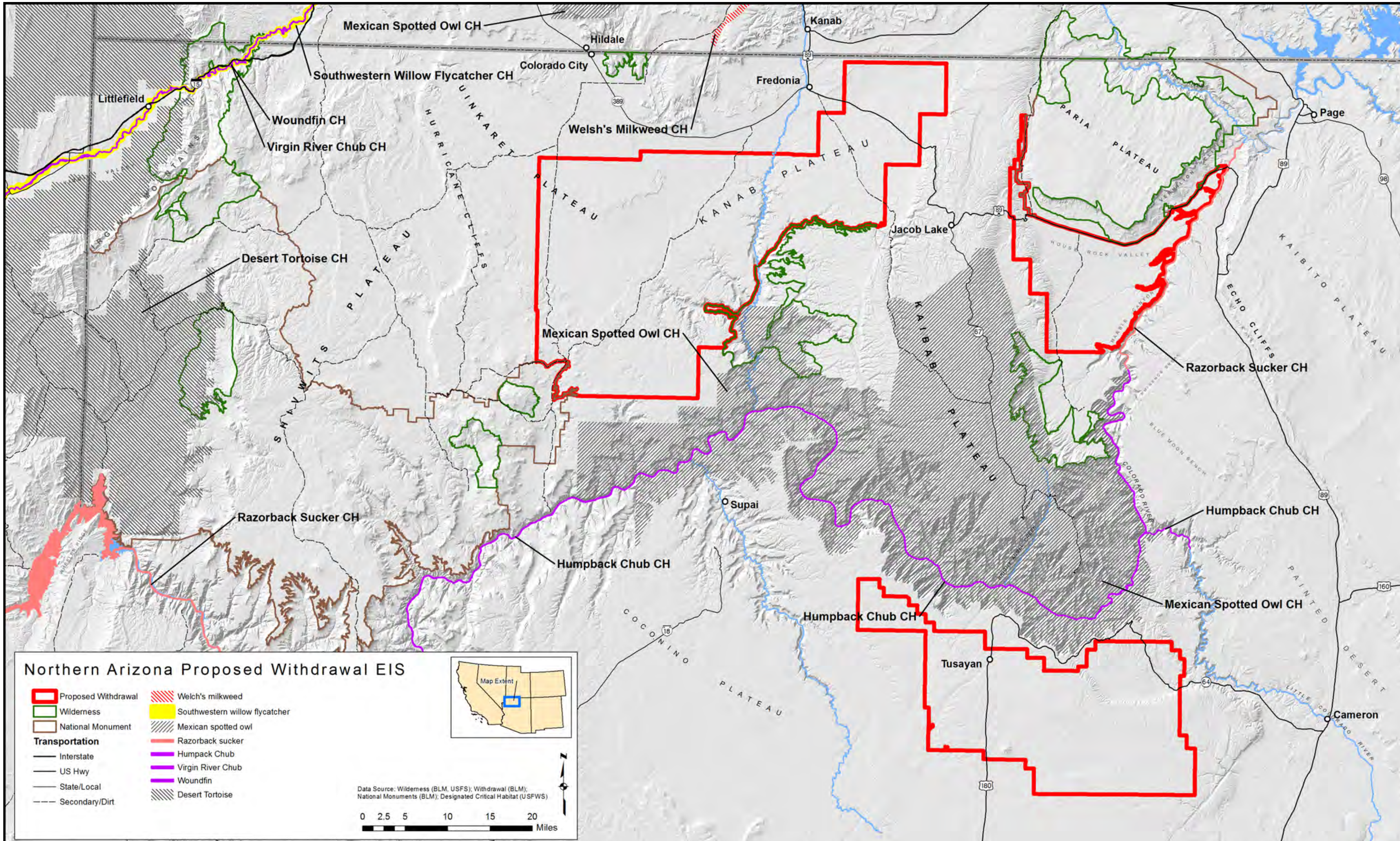


Figure 3.8-5. Critical habitat.

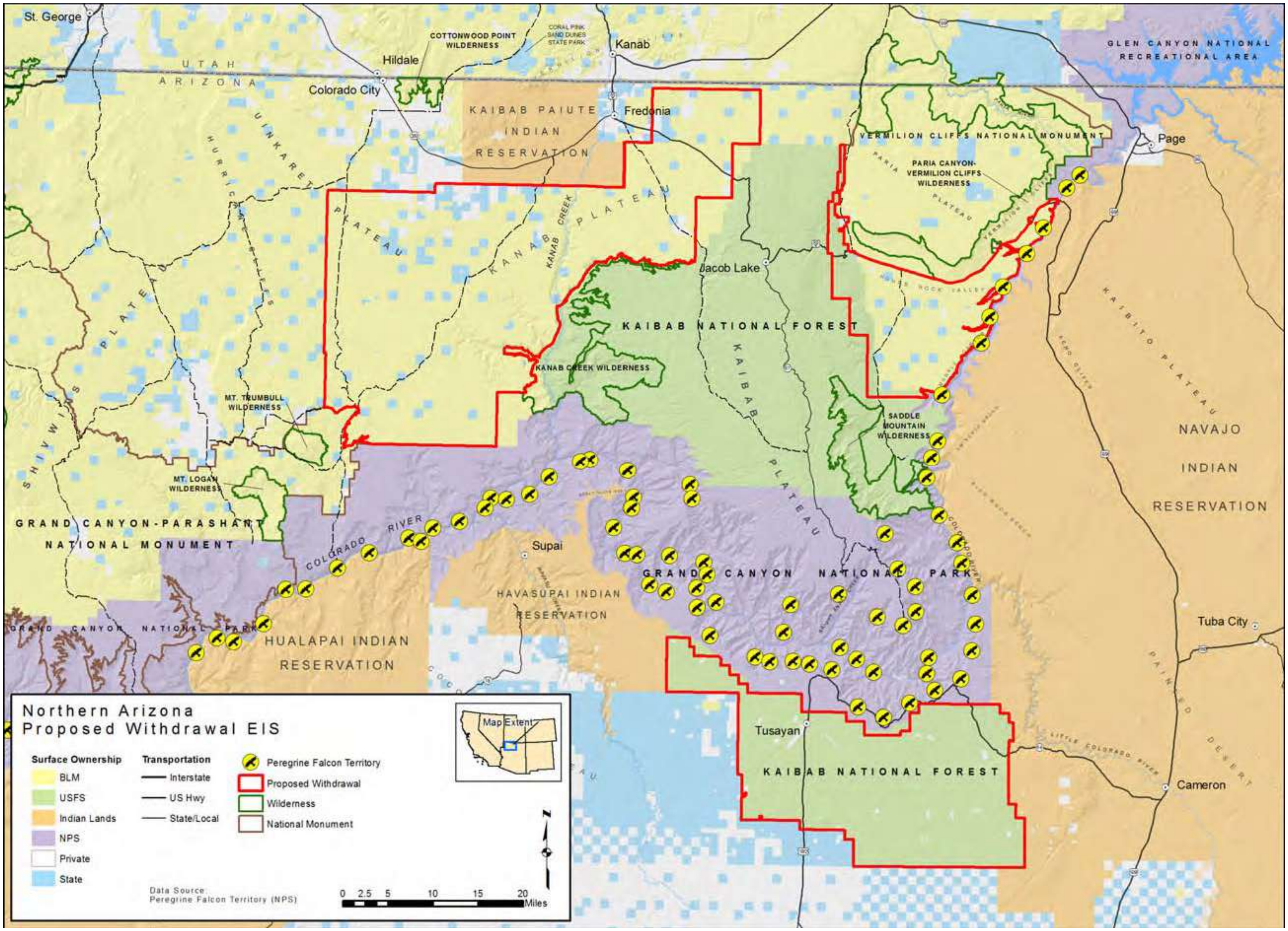


Figure 3.8-6. Peregrine falcon.

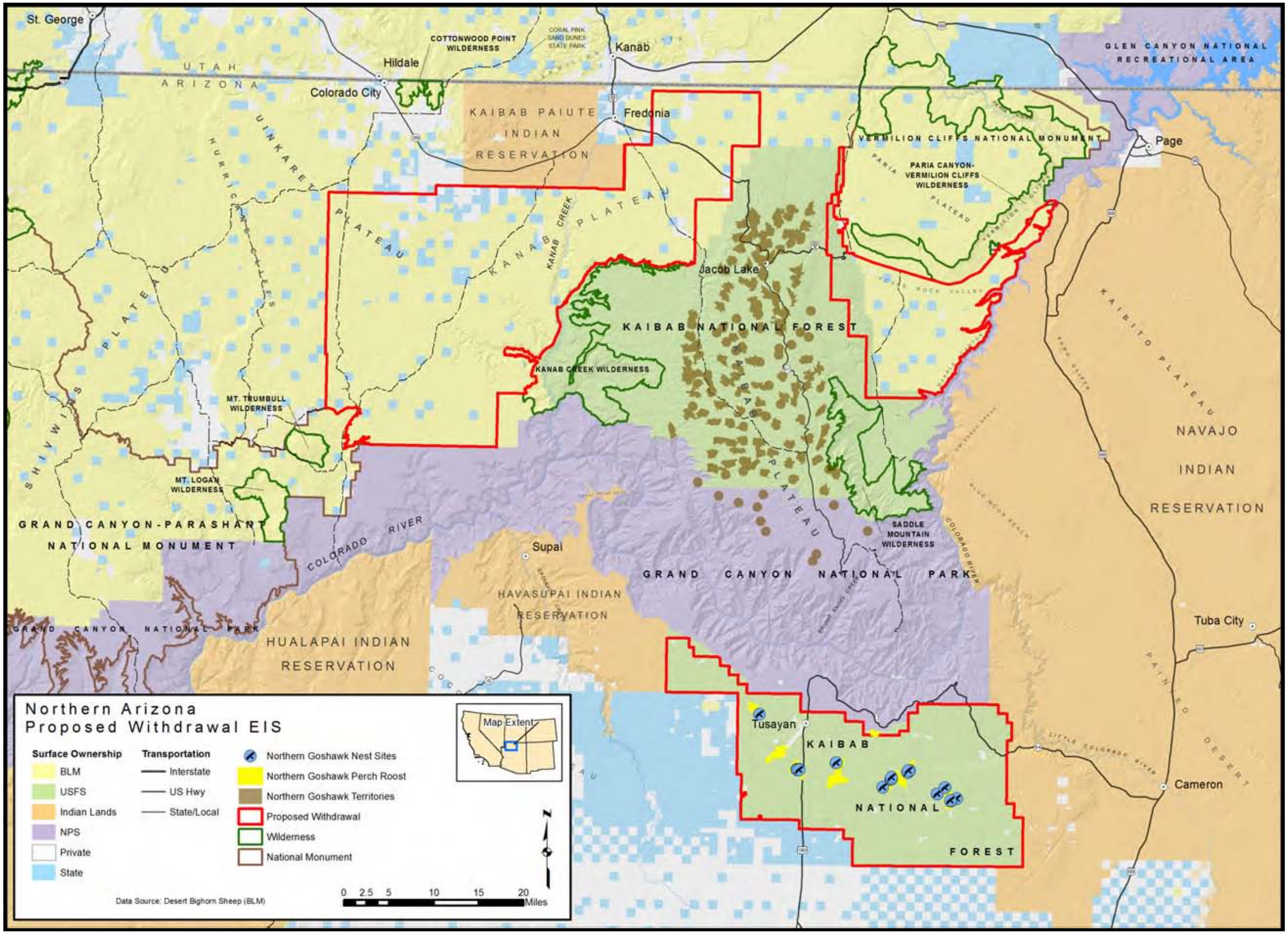


Figure 3.8-7. Northern goshawk.

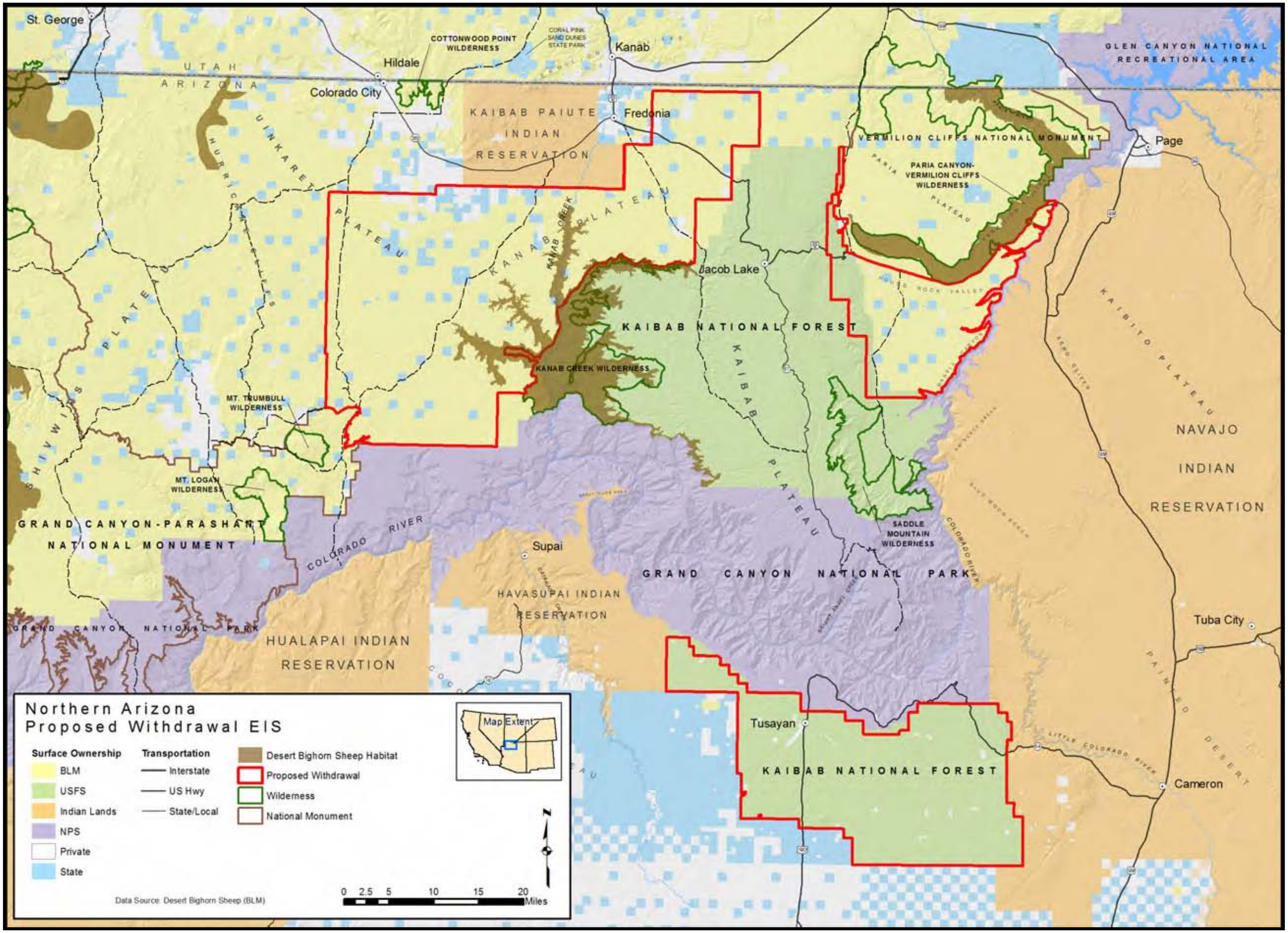


Figure 3.8-8. Desert bighorn sheep.

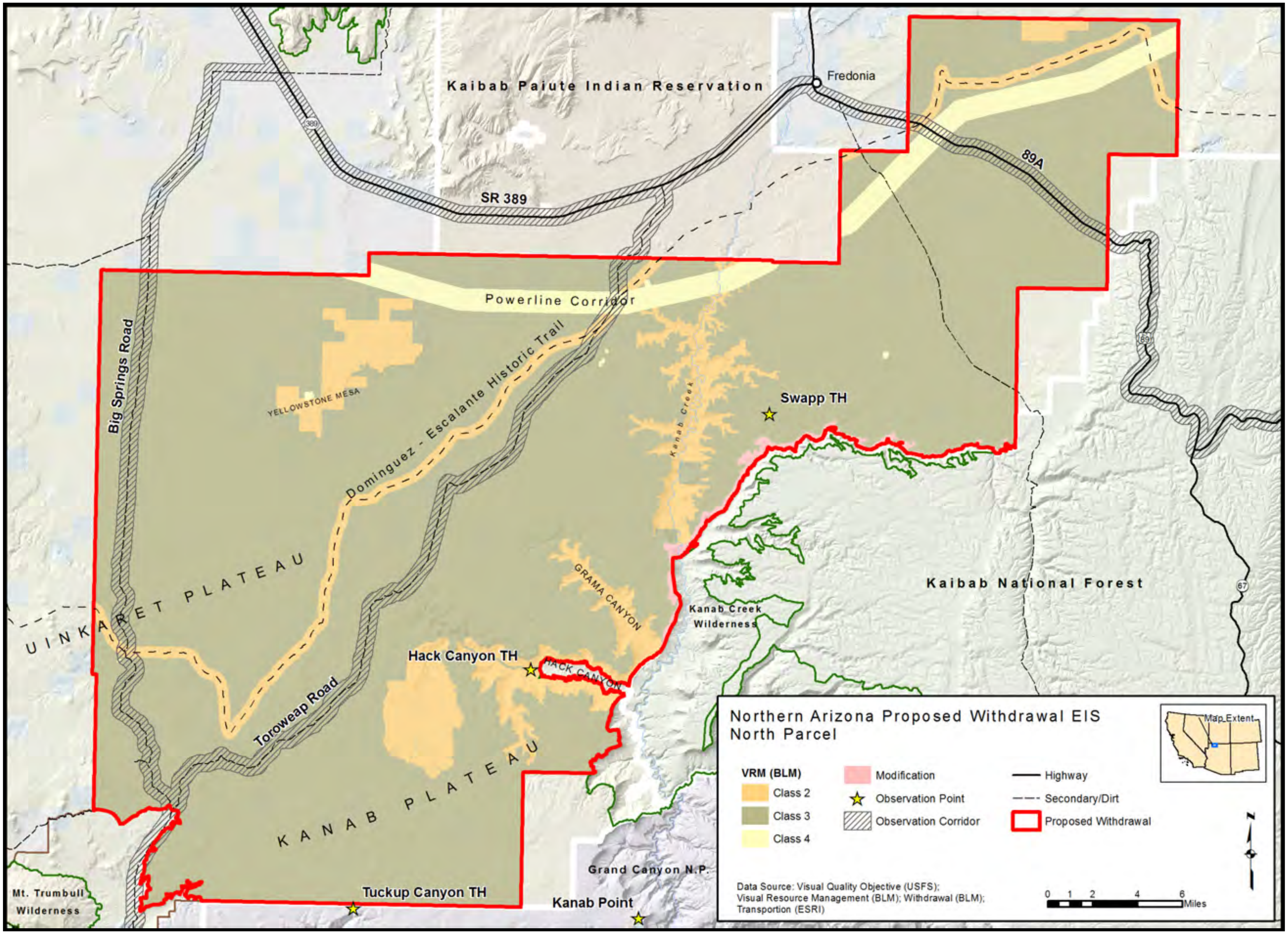


Figure 3.9-1. Visual resource management classes of the North Parcel.

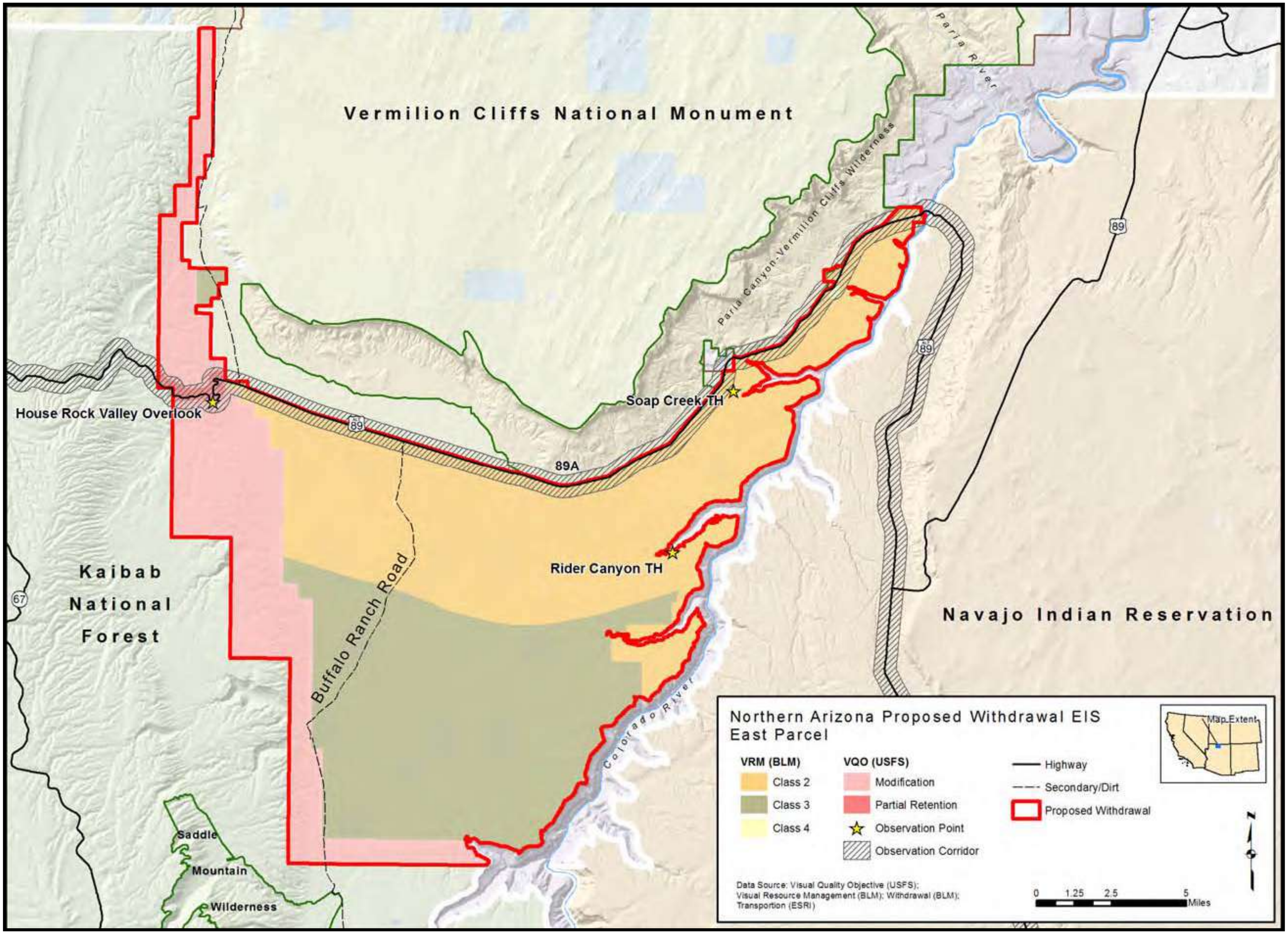


Figure 3.9-2. Visual resource management classes of the East Parcel.

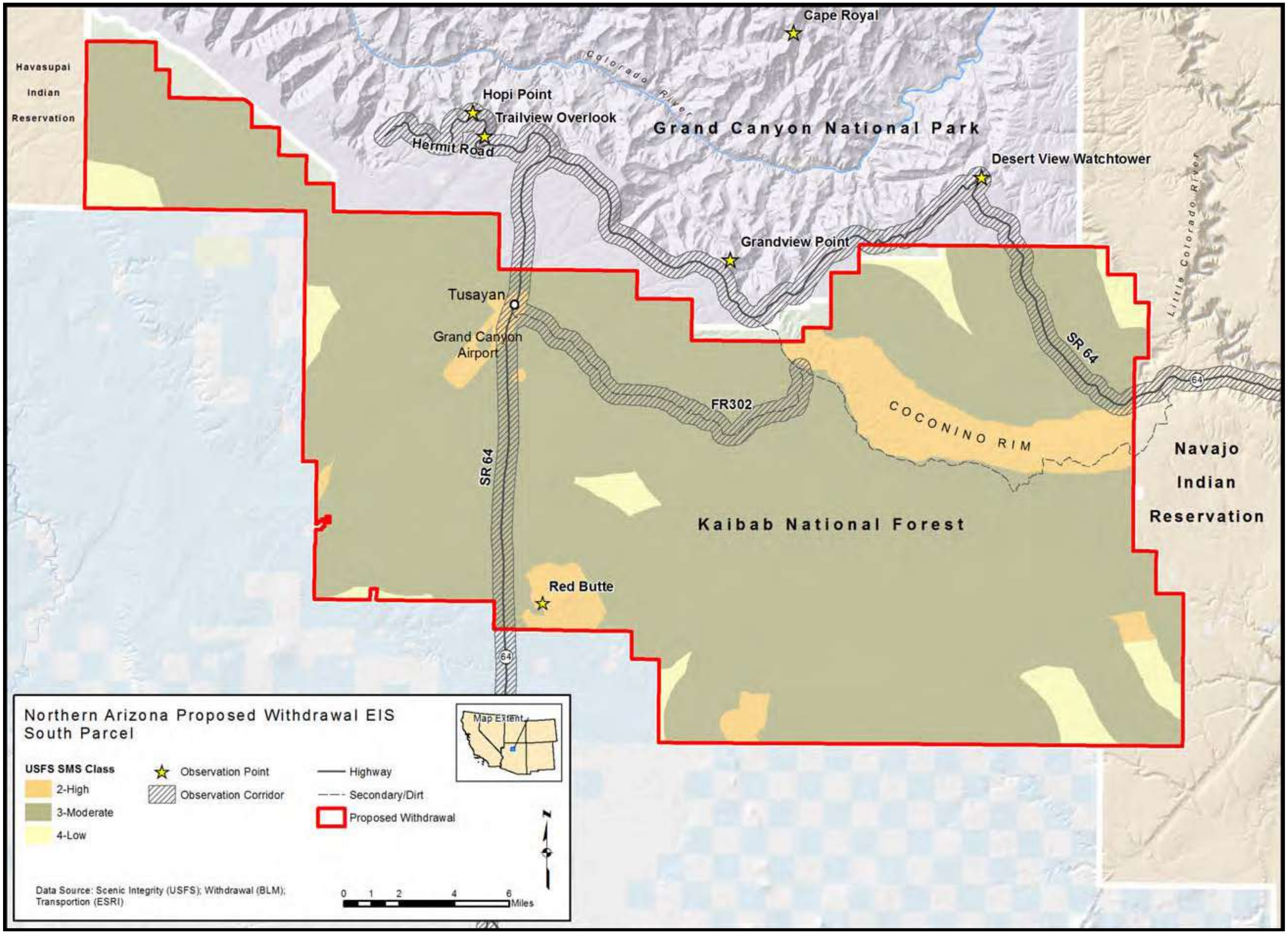


Figure 3.9-3. Scenery Management System classes of the South Parcel.