COMMENTS AND CONCERNS

REGARDING THE PROPOSED WATE MINE

AND POTENTIALS FOR EXPANDED ARIZONA STATE LAND

BRECCIA PIPE URANIUM MINING

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May 9, 2013

EXECUTIVE SUMMARY

The National Park Service is concerned with recent breccia pipe uranium exploration and the application for a new mine on Arizona State Land within the Grand Canyon watershed. The proposed Wate Mine is located in proximity to Grand Canyon National Park, the Havasupai and Hualapai Indian Reservations, and a private ranch operated by the Navajo Nation, and has the potential to impact all of these entities. In 2012, the selection of the alternative recommending the full withdrawal for 20 years of approximately 1 million acres of federal land surrounding Grand Canyon was a large step in fully protecting the Grand Canyon watershed from mining impacts. Not only do the same resources, concerns, and impact potentials that informed the federal withdrawal decision exist on the State Lands discussed in this report, but these areas are some of the last remaining parcels of land from having nearly full protections from mining-related impacts on the Grand Canyon watershed. An inspection of the Wate Mining Company's Mineral Development Report identifies several inaccuracies, assumptions, and contradictions, as well as many areas for potential future environmental degradation extending well beyond the limits of State Land holdings.

This report discusses the decision to withdrawal the approximately 1 million acres of federal land from new mining entry in 2012, its connection and similarity to the Arizona State Lands in question, and the potential uranium mining has to impact surface and groundwater systems and the communities and ecosystems that rely on them. Several theories promoted by pro-mining entities on breccia pipe mineralization and the behavior of the hydrologic system in the area are challenged. A summary of comments and concerns specific to the proposed Wate Mine is included as a table, and concerns are outlined on how approval of the Wate Mine might set the precedent for extensive mining at the large number of already identified breccia pipe targets in the area. While only one mine or one well could cause resource impacts, it is the potential cumulative impact of several wells and/or several mines that is the cause of most concern.

If the Arizona State Land Department proceeds with approval of the Wate Mine and others within the Grand Canyon watershed, it is recommended that the provided best management practices for breccia pipe uranium mining be followed to most effectively mitigate impacts to the region.

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URANIUM MINING IN NORTHERN ARIZONA

History of Federal Withdrawal

As a response to a dramatic increase in new mining claims targeting mineralized breccia pipes in Northern Arizona, and the potential environmental consequences of mining within the Grand Canyon watershed, the Secretary of the Interior withdrew approximately 1 million acres of federal land (Bureau of Land Management/BLM, and U.S. Forest Service/USFS) from mineral entry for two years in July 2009. During this two-year period, studies were conducted to inform the development of an Environmental Impact Statement (EIS) to analyze a number of alternatives including the full withdrawal of approximately 1 million acres of federal land in three parcels to entry under the Mining Law of 1872 for a period of 20 years (BLM, 2011). The BLM was the lead agency in the creation of the EIS, but the document was developed in collaboration with 15 state, federal, local, and tribal cooperators.

Alternative B, withdrawing the full 1,006,545 acres for a period of 20 years, was selected as the proposed action of the EIS. The purpose of the proposed action was to best protect the natural, cultural, and social resources in the Grand Canyon watershed from "possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that would occur within the three areas proposed for withdrawal." (BLM, 2011). The issue was of great importance to the local communities, the region, and even worldwide, with over 350,000 public comments from more than 90 countries, attesting to the importance the Grand Canyon region holds on a worldwide scale, and the need to protect it and the resources found within.

Secretary of the Interior Ken Salazar announced in January of 2012 his decision to withdrawal the over 1 million acres for the next 20 years. During this time, research on the potential impacts of expanded mining will be conducted, and monitoring of the valid existing claims that were allowed to proceed with mining will be completed.

Arizona State Land Mineral Development

Since the announcement of the withdrawal of these federal lands, mineral exploration companies, largely Vane Minerals (VANE) and Uranium One (U1) through a joint venture, have turned their focus to Arizona State Land parcels which were unaffected by the federal withdrawal. Active exploration has been occurring at a number of targets, largely located in the area within the Cataract Canyon/Havasu Creek surface and groundwater basins. **Figure 1** is reproduced from the withdrawal EIS (Figure 1.1-1) and illustrates the three parcels included in the federal withdrawal surrounding Grand Canyon National Park. These newly withdrawn areas in combination with existing mining bans on National Park Service lands and the Navajo, Havasupai, and Hualapai Reservations has now protected much of the Grand Canyon watershed from impacts from mining activities. The area within this watershed that remains a potential for substantial injury to water resources and the species and ecosystems that rely on them is the checker-boarded area of Arizona State Land and privately-held sections located to the south of Grand Canyon National Park, and adjacent to the Havasupai Tribe, Hualapai Tribe, Kaibab National Forest, and the Boquillas Ranch operated on private lands by the Navajo Nation (**Figure 1**).

Resource Concerns

Water Resources

Grand Canyon National Park has considerable concerns about the expansion of uranium mining onto State lands within the watershed that supports the park. Both water use for mining activities and the potential for water contamination degrade the health of the aquifer systems which supply springs and seeps, their reliant ecosystems, and the perennial reaches supported by groundwater that are imperative to native and endangered species. Effects of mining-related impairment to water resources will only be exacerbated by future climate change, with most scenarios predicting warmer temperatures, decreased precipitation, and an overall increase in water stresses (NCADAC, 2013; Trenberth and others, 2007).

The withdrawal EIS found that under all alternatives, impacts to water resources "ranges from none to major and impact duration ranges from short to long term" (BLM, 2011). This wide range is a result of the varying nature of the alternatives including the number and location of potential mine sites, but also partly a result of the uncertainties surrounding the behavior of local and regional groundwater systems and their interactions with mineralized breccia pipes. A range of claims and interpretations regarding these topics are used to support arguments both for and against mining, some of which are discussed in a later section.

A summary of water resources including likely aquifer system characteristics, groundwater flow paths, and discharge points from both perched and regional aquifer systems are discussed in detail in Chapter 3.4 of the EIS. A supplementary report to inform the EIS on the effects of 1980s uranium mining and water chemistry of wells, springs, and streams, among other topics, was prepared by the USGS (Alpine, 2010). Ambiguities and unknowns were identified in this report, especially when concerning groundwater. Chapter C of this report states that a more thorough investigation is required to "better understand groundwater flowpaths, travel times, and contributions from mining activities" in the area (Bills and others, 2010). It cannot be presumed that these systems are well enough understood to claim that breccia pipe uranium mining has no potential to contaminate or reduce groundwater resources that supply springs, seeps, and the ecosystems that rely on them, nor that mining will definitely result in these impacts. It is these unknowns that need to be taken into account when determining the potential long-term impacts of a single new uranium mine or many new mines over the course of decades.

Detrimental impacts to groundwater resources have been seen at a number of previous and ongoing uranium mining sites in Northern Arizona. Previous sampling summarized by the USGS in 2010 showed that 15 springs and 5 wells contained dissolved uranium concentrations in excess of U.S. Environmental Protection Agency (EPA) standards for drinking water. These locations "are related to mining processes." (Bills and others, 2010). The regional aquifer groundwater wells at the Canyon, Pinenut, and Hermit mines as well as the sumps at the base of the Pigeon and Hermit mines have all exhibited dissolved uranium concentrations in excess of drinking water standards (30 micrograms per liter, μg/L), with sump concentrations in the Hermit Mine exceeding 36,000 μg/L (Bills and others, 2010). These contaminants are not static within the groundwater system, and will leave the site along the prevailing hydraulic gradient. It is a complicated matter of the direction and magnitude of the hydraulic gradient, the role of geologic structures, and the amount of mixing/dilution that determines if and when impacted groundwater reaches a discharge point at a spring or seep, and at what magnitude the impact will be felt. This is another example of the many ambiguities that make interpretations difficult.

While often in a quiescent, reduced state within an undisturbed ore body in a breccia pipe, uranium and other minerals oxidize rapidly (within 6 months) in open underground mine workings and become mobile (Wenrich and others, 1995). Uraninite (uranium in the reduced (IV) state) has a low solubility and thus mobility. Once oxidized to the hexavalent (VI) state, it is most susceptible to environmental transport and biological intake (Ginder-Vogel, 2006). The USGS has previously used spring geochemistry to assist in locating nearby uranium-mineralized breccia pipes with "considerable success" on the Hualapai Reservation (Wenrich and others, 1994). The success of this investigation supports the presumption that groundwater does interact with mineralized breccia pipes. This would likely only be exacerbated in the future by groundwater interaction with hydraulically-enhanced mined pipes with oxidized ore.

During mining operations, risks exist not only from shallow groundwater entering the underground workings, but from surface water entering the subsurface through the surface expression of the breccia pipe and/or the shafts installed to extract ore or ventilate the mine. For example, the currently proposed Wate Mine has plans to have all surface mining operations located above a 500-year flood level, but the pipe itself is still located in a depression within a drainage feature. Evidence from a visit to the Wate pipe site visit shows that the surface expression of the breccia pipe holds water at times. The Orphan Mine, located just below the South Rim in Grand Canyon National Park, has flooded on multiple occasions, resulting in standing water in the mine workings of between 1 and 3 feet in the two cases referenced here. The event that occurred in May 1961 (Chenoweth, 1986) was directly related to heavy rains, while flooding observed in 1981 (Day and others, 1981) may have been related to precipitation and/or accumulation of shallow groundwater entering the mine workings.

Effects on the Greater Ecosystem

In addition to potential impacts to water quality in and around Grand Canyon National Park, reductions in water availability due to pumping from wells to support mining activities have far-reaching effects. Drying or degradation of springs and seeps affects a wide swath of the ecosystem including fish, amphibians, birds, insects, mammals and riparian vegetation. Additionally, degradation of springs and seeps reduces availability of human use and recreation, and impacts unquantifiable cultural significances.

Grand Canyon National Park shares a boundary with the Havasupai Tribe along Havasu Creek at Beaver Falls. Havasu Creek is one of the largest tributaries to the Colorado River in Grand Canyon, and is supported solely by discharge from a number of springs found within Cataract Canyon on the Havasupai Reservation. Not only does water from these springs support the village of Supai, it provides water to the thousands of tourists that visit the canyon each year, and is held sacred not only to the Havasupai, but to other tribes in the region as well. Downstream from the source springs, this baseflow supports a lush riparian corridor in an otherwise arid environment all the way to the confluence with the Colorado River. This area is popular with tourists not only coming down from the Havasupai Reservation, but also coming up from the Colorado River within the park. The turquoise waters and spectacular travertine falls and formations are internationally known.

Within the spring-supported waters of Havasu Creek, a number of native fish populations including bluehead suckers, flannelmouth suckers, and humpback chub exist. The humpback chub is protected under the Endangered Species Act. There are only six recognized populations of this fish remaining, with the largest located in Grand Canyon National Park near the confluence with the Little Colorado River. In an effort to establish a second population of humpback chub in the park, an evaluation of potential tributary translocation sites was made, and Havasu Creek was ranked the highest (Valdez and others, 2000). Humpback chub translocations were later included as a Conservation Measure in the Biological Opinion on the Operation of Glen Canyon Dam by the U.S. Fish and Wildlife Service (USFWS, 2008) and as a result are currently being funded by the U.S. Bureau of Reclamation and conducted by the National Park Service. In Havasu Creek, the site of the translocations was selected at a series of pools at the base of Beaver Falls on the boundary of the National Park and the Havasupai Reservation. During evaluation of Havasu Creek for translocations, a small population of existing humpback chub was discovered here, supporting the conclusion that this is ideal habitat for the species. The first two of three planned annual translocations occurred in June 2011 and 2012 for a total of 543 fish (Trammell and others, 2012).

Not only are these fish susceptible to reduction in the quality and quantity of water from the springs supplying flow to Havasu Creek, they can potentially be impacted from surface water flows draining the plateaus where mines may be developed. For example, the currently proposed Wate Mine lies within an unnamed wash that flows north and feeds into Little Coyote Canyon, a tributary of Havasu Creek that discharges at the National Park-Havasupai Reservation boundary at Beaver Falls, at the exact spot where the endangered humpback chub have and will be translocated (**Figure 2**). Extreme precipitation events and failures of containment features at mine sites, such as what has been observed on the Puerco River near Church Rock, NM (Wirt, 1994) and in Northern Arizona at the Hack 1 Mine (Otton and others, 2010) have the potential to rapidly deposit contaminated materials long distances downstream from a mine site, affecting a much larger area than the small footprint of the mine site would suggest.

<u>Conflicting Information</u>

Arguments made by entities supporting Northern Arizona uranium mining often involve claims that uranium ore bodies are located 1,000ft or more above the regional water table, and that a thick section of impermeable rock separates the mines from the regional aquifer, isolating the two and eliminating the possibilities of contamination. Results from a number of respected studies cast doubt on or outright refute these assumptions.

Breccia pipes on the Coconino Plateau often form surface depressions due to the collapse of material below that are then filled with sediments. These basins collect water, and therefore "may have a significant effect on the regional occurrence and movement of groundwater." (Bills, 2007). Geologist

Karen Wenrich stated in a legislative hearing to the Committee on Natural Resources in 2009 (as an advocate for uranium mining) that a "1,089-foot thick unsaturated, practically impermeable, layer of the Supai Group Sandstone" protects the regional aquifer from the ore bodies above (Wenrich, 2009). However, while researching breccia pipes in Northern Arizona for the USGS, she reported that "the brecciated nature of the pipes provides an excellent conduit for rain water and snow melt to enter the aquifer system" and that the pipes "act as conduits for fluid movement between aquifers." (Wenrich and others, 1994). A Master's thesis on the Sage breccia pipe, located near the currently proposed Wate pipe mine and stated to have the same rock characteristics as Wate (VANE, 2012), determined that "the permeable conduit provided a plumbing system through which downward and/or upward moving mineralizing fluids were allowed to pass." (Mazeika, 2002). Although the native, un-brecciated geologic strata surrounding the pipes is relatively impermeable where it has not been otherwise disturbed, this does not seem to be the case for the breccia pipes themselves. The mere presence of concentrated mineralization is indicative of fluid movement through the pipes.

Another argument made is that the depth of uranium ore bodies does not exceed the level of the Esplanade Sandstone (upper member of the Supai Group) (Wenrich, 2009). Statements that ore does not extend below this are simply not true. Uranium mineralization is known to occur in the breccia pipes of Northern Arizona between the lower Toroweap Formation and the top of the Redwall Limestone (Casadevall, 1989). These statements arise because the extent of economically-viable uranium ore is generally in this horizon and mining often does not extend beyond this because either the grade of the ore or the cost of extracting at increasing depths do not make this enticing. Increased uranium prices in the future may change these strategies however, and prompt deeper ore extraction. Uranium mineralization is found to a depth of nearly 1,900ft at the Wate pipe (SRK, 2011, Figure 10-2) and at the Canyon Mine is found between 600ft and over 2,100ft (RPA, 2012). This depth is within approximately 300ft of the depth to water of wells located in the Town of Tusayan, approximately 6 miles away.

Adding to claims that uranium mining can be done in a safe and clean manner, an argument is often made that although this was not often done in the past (Orphan Mine in Grand Canyon National Park and a multitude of uranium mines on the Navajo Reservation; for example), new site reclamation protocols are so successful that no evidence is seen at previously mined breccia pipes that a mine ever existed. Grading and re-vegetating sites post-mining is beneficial from the standpoint of returning the landscape to a pre-mining *appearance*, but claims that these result in no evidence of past mining is misleading. Even reclamation success stories of Northern Arizona mines such as the Hack 1, 2, and 3 mines, the Pigeon Mine, and the Hermit Mine have legacy impacts. Soil contamination remains in the form of anomalous concentrations of elements such as uranium and arsenic and elevated radiation is still found at each of these sites. Wind dispersion of dust has spread these contaminants well beyond the boundaries of the mine operations (Otton and others, 2010). In the subsurface, the excavated mine workings are partially refilled with waste rock and ore of a grade not economical enough to extract and process. These voids can then fill with shallow groundwater (if present), react with the remaining ore and eventually migrate off-site. Timescales for this process may be on the order of decades or more, but does not mean that this is an acceptable outcome for the mine.

COMMENTS ON PROPOSED WATE MINE

Specific comments and concerns related to the proposed Wate Mine by VANE Minerals LLC are compiled into **Table 1**.

CONCERNS WITH EXPANDED STATE LAND MINERAL DEVELOPMENT

More troubling than the approval and operation of the proposed Wate Mine is the precedent this mine could set for substantial development of more State Land breccia pipes, and Grand Canyon National Park views the Wate claim as an example of potential future mineral development in the Grand Canyon watershed. Considering the approximately 1 million acres of federal land in three parcels withdrawn in 2012, the federal lands of Grand Canyon National Park and Grand Canyon-Parashant National Monument, and the tribal lands of the Hualapai, Havasupai, and Navajo Reservations, the State Land parcels open to mineral entry are some of the last remaining areas preventing a protective zone around the entirety of the Grand Canyon watershed (**Figure 1**). By remaining open to mineral entry, these State Land parcels are now seeing concentrated interest by mining companies as the last chance to mine uranium in Northern Arizona and they are being heavily explored for any site that may provide an economic return.

Although individual mines may have a small surface footprint and limited potentials for landscape-scale impacts, the need exists to investigate the potential impacts of many mines over many years. Numerous other breccia pipes in this area are currently being explored (**Figure 3**), and several have already defined ore-grade resources. Even if each mine has a low likelihood of producing a situation where resources are measurably damaged, simple probability shows that with each new mine that situation becomes more plausible. The total number of mineralized breccia pipes on State Land parcels on the Coconino Plateau is not even known and may be substantially larger than what is identified by surface features. New electromagnetic geophysical techniques are locating "blind pipes" where a pipe exists at depth, but is not evident at the surface. The VANE Minerals website states that the Joint Venture between VANE and Uranium One has "recently generated 126 defined pipe targets on state land, many of which were identified by state-of-the-art airborne VTEM and MegaTEM geophysical data." (www.vaneminerals.com, 2013).

Shared roads for local, tourism, and mining traffic at the proposed Wate Mine will not be as substantial an impact to Grand Canyon National Park as it will for the Hualapai and Havasupai Tribes, but if mining were to continue at other targets further east, State Route 64 would likely become the access point to the mine(s) and part of the route for ore transport. State Route 64 is the main artery bringing tourists into the Grand Canyon's South Rim. The park receives approximately 4.5 million visitors annually; disruptions to travel along this corridor due to mining, construction, or ore transport activities or mishaps could be devastating. Expanded State Land mining could also incentivize the development of a uranium ore mill in Northern Arizona to defray the costs associated with the current extensive travel routes to mill sites in Utah. With multiple mines potentially extracting ore concurrently or in series, it may become economically feasible to propose construction of a mill nearby, increasing the potential for long-term air, water, soil, and biological contamination of the region.

Expanded mining also results in a cumulative groundwater use that may become detrimental to the regional aquifer system over time. The Wate Mine proposes to use 15,000 gallons per day (VANE, 2012) for the life of the mine. Expanding this water appetite to many mines over a large area of the Coconino Plateau, impact to already stressed water resources could occur. The region has been in a drought for over 10 years (Cook and others, 2004; McCabe and others, 2004; Phillips and Blakemore, 2005), and estimates on future water needs on the Coconino Plateau even before potential mining is taken into account show that the region will have an unmet water need by 2050 (BOR, 2006). Even small declines in the amount of water available to springs and seeps can change a perennial spring to an intermittent one, or cause an intermittent water source to dry up completely, both resulting in devastating effects on the ecosystems that rely on that water (NPS, 2012).

Beyond the potential effects to springs and seeps, expanded mining on targets already identified could have impacts on the quality and quantity of water in wells completed in the regional aquifer. For example, the Havasupai Tribe's Bar Four well is only 5 miles away and down-gradient from the section containing VANE's Faith and Brimmer targets, and several targets including the Miller, Wilhala, and Antelope pipes are within 10 miles of the water supply wells in the community of Valle (**Figure 3**). The potential impact of uranium mining activities should not be gauged on if degradation reaches some acceptability threshold such as a State or Federal drinking water standard or aquifer drawdown limit. Grand Canyon National Park as well as the Tribal communities surrounding the canyon views any level of resource degradation resulting from uranium mining as unacceptable, whether it crosses some defined threshold or not.

While it is true that vertical distances between targeted ore bodies and the regional aquifer may be hundreds of feet or more and that travel times of groundwater can be quite slow through these geologic materials, one needs to think in terms of future impacts. It may take decades or more for impacts to be seen at springs, and if multiple mines are operating in the time that it takes the legacy of an earlier mine to manifest itself, the issue has already likely compounded itself. Formation of the breccia pipes and the uranium ore bodies contained within occurred over geologic timescales, and therefore the potential impacts resulting from the disturbance of this ore may take a similar time to become apparent.

CONCLUSIONS / RECOMMENDATIONS

The number of unknowns and ambiguities related to breccia pipe uranium mining's lasting effects on the Grand Canyon watershed begs the need to take a more precautionary position on claim approvals. While operation of one State Land uranium mine might be determined to have limited chances for environmental impact, the precedent set by approving that mine could allow untold additional explorations and mines, dramatically increasing the potential for future resource injury. The physical and geochemical characteristics of the breccia pipes, the existence and behavior of shallow and deep regional groundwater, flow paths and travel times of those waters, and the impacts mine-related contamination could have on the ecosystem are all examples of subjects that are not fully understood in this area. Even small reductions in water availability or the quality of water, soil, or air may have profound effects on native ecosystems, endangered species, visitor experience, and tribal resources and values, among others.

The science and reasoning behind the Secretary of the Interior selecting the proposed action to withdraw the full 1,006,545 acres from new mineral entry for a period of 20 years are appropriately similar to the area currently being explored for breccia pipe uranium ore deposits on State Land parcels. In addition to the 2012 federal withdrawal, the Hualapai Tribe (2009), Havasupai Tribe (1939), and Navajo Nation (2005), whose lands border the existing mining targets, are all on record as opposing and/or prohibiting uranium mining, and the Coconino County Board of Supervisors is in opposition to uranium development on lands within the Grand Canyon watershed (2008). Grand Canyon National Park is in agreement with these entities that the lingering effects of historic uranium mining in the region and the potentials for future impact are simply too great a risk. These State Land parcels open to mineral entry are some of the last remaining areas preventing a protective zone around the entirety of the Grand Canyon watershed.

The Arizona State Land Department has already closed a number of sections of land to mineral entry to protect a portion of Cataract/Havasu Canyon (Closure Order 551-86/87, appended by 251-2010/2011) (**Figure 3**). While admirable, this order only partially protects a section of the surface watershed of Cataract Canyon. The remainder of the surface watershed and the groundwater basin supporting Havasu Creek extends well beyond this closure area and warrants similar protections. Rather than setting a precedent for expanded uranium mining on the Coconino Plateau by approving the Wate Mine, the State Land Department has the opportunity to set a precedent by expanding current mineral closures to protect the Grand Canyon watershed from potential impacts resulting from breccia pipe uranium mining. Such an action would be in line with the State Land Department agency goal to "incorporate environmental protection into the Department's management actions to enhance the future productivity of the Trust's land and assets." (AZSLD, 2013).

If, however, the State Land Department proceeds with approval of the Wate Mine and/or future mineral exploration and extraction activities within the Grand Canyon watershed, Grand Canyon National Park recommends the Department adopt recently-created Best Management Practices (BMPs) for mining operations to most effectively mitigate impacts to the region. These BMPs are provided as **Appendix A**. In making its decisions on this matter, the National Park Service trusts that the Department will continue with its commitment "to provide for Arizona's growth, open space, and Trust resources through responsible, and well considered, land management strategies."

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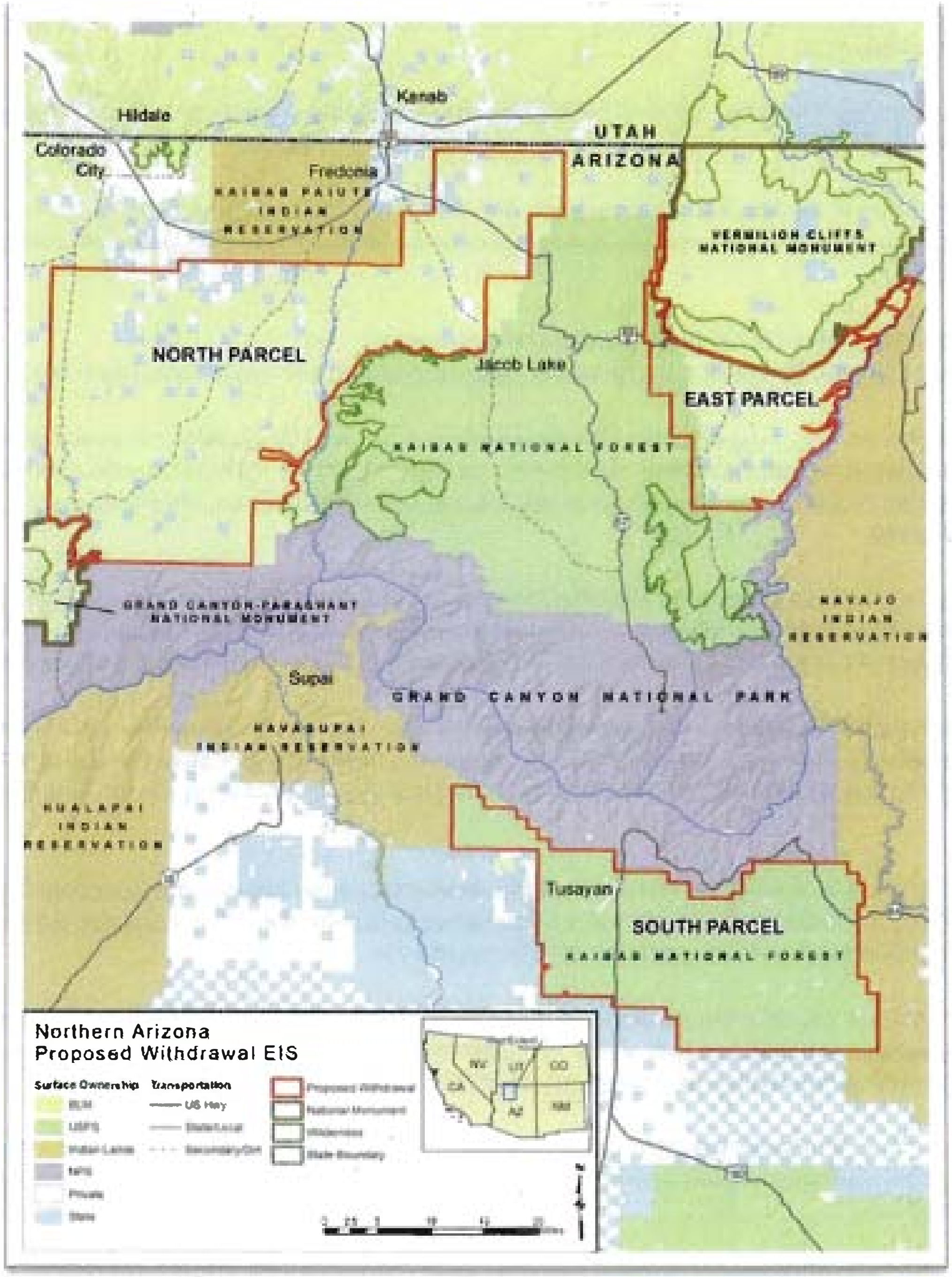

Figure 1. Regional land ownership and withdrawal parcels in Northern Arizona, from Withdrawal EIS (BLM, 2011, Figure 1.1-1).

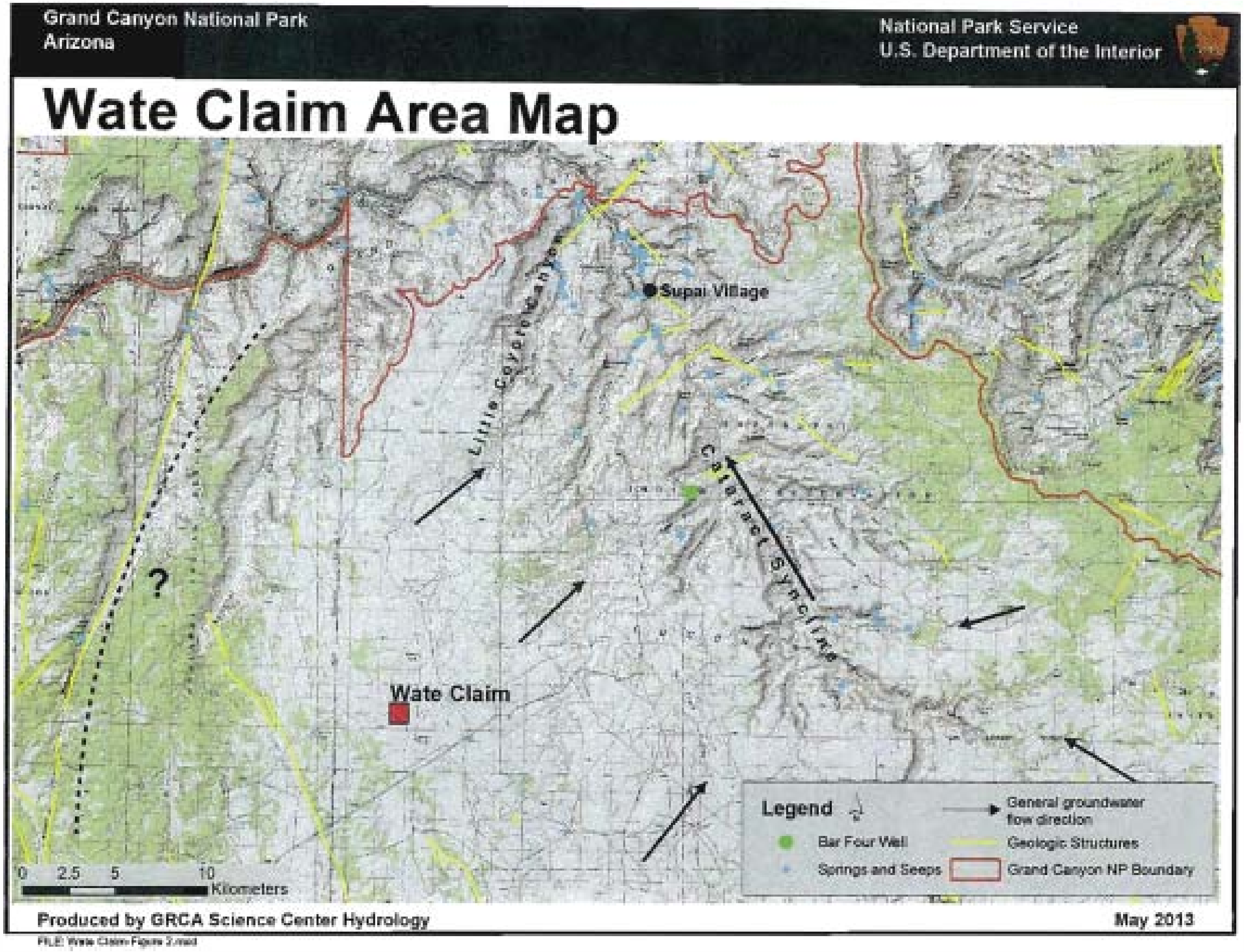

Figure 2. Wate Claim area map with general groundwater flow directions and known springs and seeps.

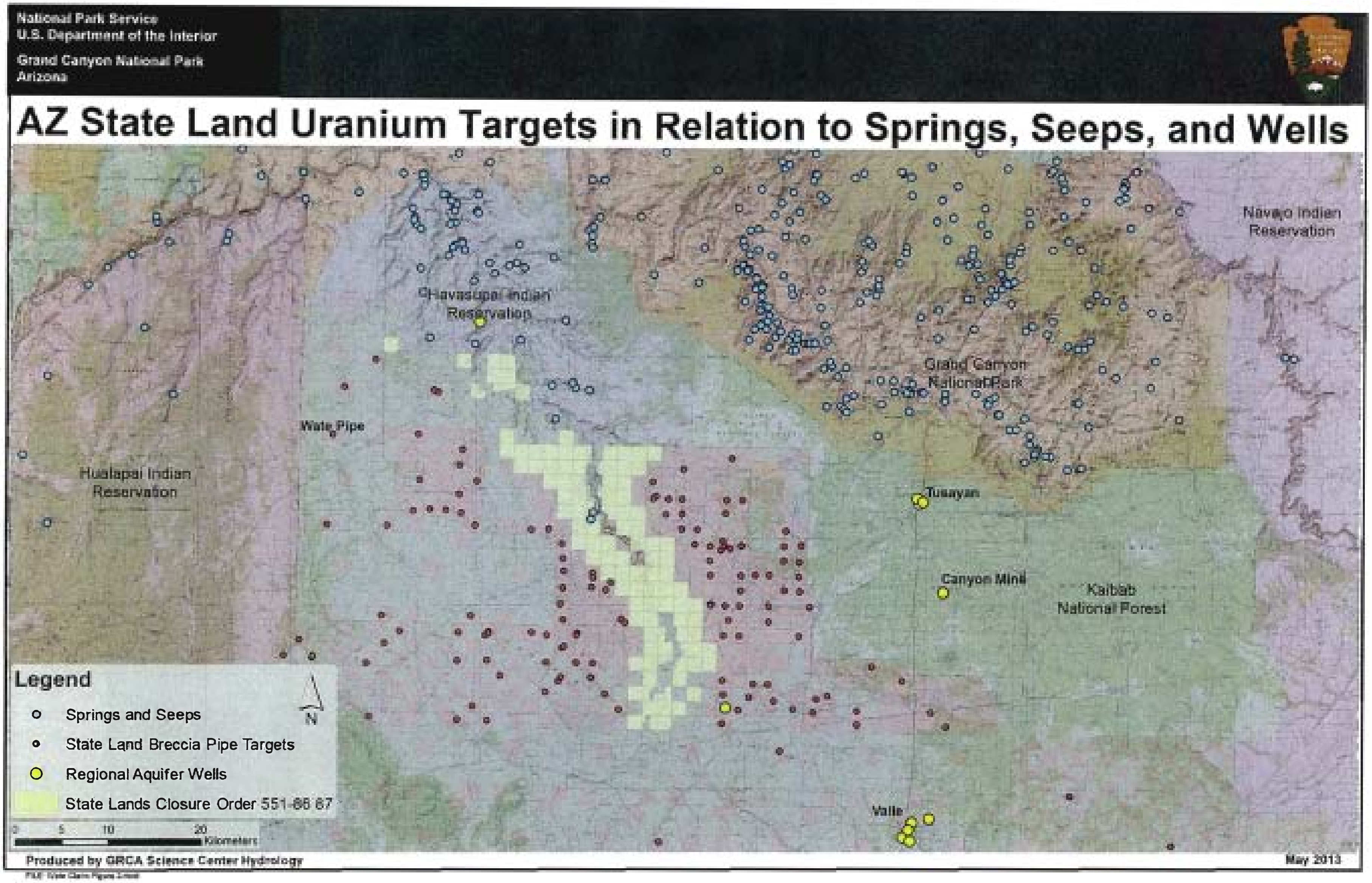

Figure 3. State Land uranium targets showing proximity to mineral closures, springs, seeps, and wells.

Figure 4. Aerial view of Wate Claim showing topsoil scraping conducted to locate previous drill holes.

Table 1. Document review comment form, Mineral Development Report for Wate Claim.

DOCUMENT REVIEW COMMENT FORM-GRAND CANYON NATIONAL PARK

Section	Page	Comment/Change
1.2	5 of 52	VANE and partner Uranium One (U1) state that 1.0million lbs U_3O_8 is the "minimum threshold to proceed underground" (SRK, 2011). The original NI 43-101 Technical Report by SRK Consulting (2010) initially graded the resource at 0.70%, not making the 1million lb threshold (990,640lbs). It took additional drilling and an update to the report (2011) to attain this threshold (1.118million lbs), and just barely. This makes economic success more tenuous if U prices fluctuate, especially in the light of potential environmental permitting and monitoring stipulations, and the adoption of Best Management Practices.
1.2	5 of 52	The Mineral Development Report (MDR) states VANE will use the White Mesa Mill in Blanding UT (owned by Energy Fuels), while VANE's website states they will be using the Shootaring Canyon Mill owned by Uranium One. The location of ore processing and transportation routes are important and need to be clarified.
1.2	5 of 52	If the Shootaring Mill is to be used, it goes against claims that contamination potential will be eliminated as ore will be removed from the region. The mill is approx 13 miles N of Bullfrog Marina on Lake Powell along a well-developed wash, so processing at this location is just moving the material from the upper end of the Lower Colorado basin to the lower end of the Upper Colorado basin. A breach of containment at this location would introduce ore back into the Colorado River system.
1.3	6 of 52	"The project is in a low-lying area and therefore has no visual impact issues". This just means the site is more susceptible to water accumulation and flooding.
1.2	12 of 52	The Wate Pipe is located on the Coconino Plateau, not the Kaibab Plateau.

Section	Page	Comment/Change
1.6.1	13 of 52	"Ore grade located 1100-1900 ft. below the surface." If perched groundwater exists at the site, it may be drained by the installation of the shaft and workings, or be contaminated by exposure to mobilized metals and taken off-site along the prevailing hydraulic gradient. A shaft sump accumulating contaminated water may also transmit water downward along the axis of the pipe towards the regional aquifer.
1.6.2	13 of 52	"Ore formed in sandy breccia rock fragments and 'flow breccia' consisting of sandstone, sandy units, and un-cemented sand". This description of the ore-hosting geologic material is one of high hydraulic conductivity, easily capable of storing and transmitting groundwater, leading to potential contamination.
2.4.5	17 of 52	Does the total transportation cost during the life of the mine include costs for road maintenance from wear and tear due to ore truck transport (especially on Indian Route 18)? What about dust suppression on site and on access road(s) between the mine and Indian Route 18? The mine site and associated activities are located in the proximity of a Class I Airshed (Grand Canyon National Park), posing the potential for air quality issues.

Section	Page	Comment/Change
2.4.6	17 of 52	The reclamation cost estimation is inadequate in several areas, and is in no way a "conservative estimate". Drill sites should be plugged/abandoned according to ADWR regulations, not filled/capped as previously done. According to the SRK report, previous drill holes were left with collars sticking up above grade, and drill cuttings were left on the surface (SRK, 2011). In the MDR Table 2.1, there is no supporting cost breakdown for reclamation and closure. How was the $518,000 cost figure derived? Reclamation and monitoring costs should be re-calculated using the recommendations described in "Best Management Practices and Compliance Measures for Breccia Pipe Uranium Mining Activities in Northern Arizona" (BMPs, attached as a Appendix A). These BMPs were developed out of the Northern Arizona Proposed Withdrawal Final Environmental Impact Statement (BLM, 2011) and act as a reference guide to be considered and applied as appropriate to new mine sites within the Grand Canyon watershed.
3.1-Soils	18 of 52	Soils have been impacted on the site even before mine development. In an effort to re-locate other historic drill sites (those that were not still sticking out above grade), a large area (450' x 900') was scraped in hopes of exposing signs of these previous drilling locations (SRK, 2011). This area is quite evident on aerial imagery (**Figure 4**) and there is no evidence/report that the native soil was replaced once drilling was completed. Was this conducted prior to the site archaeological survey? Soil impacts from road development and/or expansion have not been evaluated in the assessment. Mitigation measures are found in the BMPs (Soil Resources and Facility Design Standards sections).

Section	Page	Comment/Change
3.1-Surface and Groundwater	18 of 52	A production well would need to be installed, operated, and monitored in accordance with ADWR and should reference the attached BMPs. It is not clear which BMPs are proposed to be followed by the applicant.
3.1-Surface and Groundwater	18 of 52	Which springs are referenced here? Regionally, groundwater is focused towards the axis of the Cataract Syncline, ultimately moving north and discharging at large regional aquifer springs such as Havasu Springs (Bills, 2007)(**Figure 2**). There are many shallow perched aquifer springs found in Cataract Canyon. The proposed Wate Mine is located in this basin and removal and/or degradation of both shallow and deep groundwater resources is a potential.
3.1-Surface and Groundwater	18 of 52	What study on the Sage breccia pipe are the applicants referring to? A USGS report on the Sage pipe (Brown and others, 1992) states that sandstones in the pipe were de-cemented and "poured down into the underlying void and deposited as a permeable wedge-shaped sand flow" and the uranium was deposited in "permeable breccias and flows". A Master's thesis on the Sage pipe (Mazeika, 2002) studied drill cores from the Sage pipe and determined "the permeable conduit provided a plumbing system through which downward and/or upward-moving mineralizing fluids were allowed to pass". So, even if production blasting did not increase hydraulic conductivity within the pipe, it remains as a natural element of the pipe's morphology.
3.7	21 of 52	Climate change effects have increased the frequency and magnitude of extreme precipitation events (Trenberth and others, 2007). The flood risk at this site is likely higher than that reported by the applicant, and will likely increase in the future. In fact, there are reports and site evidence that this site has flooded recently.

Section	Page	Comment/Change
3.7	22 of 52	Mine surface infrastructure may be placed above a 500-year flood level, but the pipe itself still remains in a topographic low. Site visits have shown evidence that the surface expression of the pipe holds water at times. This water may infiltrate to lower levels of the pipe and may intercept mine workings during operation and fill partially in-filled workings after site closure.
3.8.1	23 of 52	While the site is located on an unnamed shallow ephemeral drainage, this drainage feeds into Little Coyote Canyon, which then discharges into the perennial section of Havasu Creek at the boundary of the Havasupai Reservation and Grand Canyon National Park (**Figure 2**). This confluence is where translocations of endangered Humpback Chub have occurred, and where a small population existed prior to translocation. Havasu Creek is considered "critical habitat" for this endangered species, and translocations are defined as a Conservation Measure in the 2008 Biological Opinion on the operation of Glen Canyon Dam (USFWS, 2008).
3.8.1	23 of 52	Springs are located not only less than the 15 miles away stated by the applicant, but these springs also issue from shallow aquifer systems at higher elevations than claimed by the applicant (**Figure 2**). Within about 15 miles or less from the Wate parcel, there are 7 confirmed springs that discharge from aquifers above the regional Redwall-Muav aquifer (Coconino Sandstone, Esplanade Sandstone, or Supai Group), all above the 3,200ft upper limit claimed by the applicant. These springs discharge at a depth below the plateau surface of between 1,090 and 2,290ft, with 3 locations above the proposed depth of the mine shaft (1,700ft). It is evident that shallow groundwater does exist in the area. However, the extent, depth, and behavior are unknown. Creating artificial drains to these aquifers by drilling mine shafts and excavating material for ore extraction could potentially affect the locations where this groundwater discharges at the surface, although the timescales and magnitudes of impact are unknown.

Section	Page	Comment/Change
3.8.2	24 of 52	"area is south and west of the R-aquifer divide, limiting groundwater flow into Cataract drainage and not toward the South Rim Grand Canyon springs" While the proposed mine site is on the west side of the Cataract Syncline and therefore will not affect what are usually described as the "South Rim springs" (those found to the east and west of the main South Rim developed area), there are still springs located on National Park land to the north of the proposed mine (**Figure 2**). Additionally, Havasu Creek below Beaver Falls is in the National Park, and discharge from all of the springs in Cataract Canyon add to the flow of Havasu Creek, providing habitat for endangered fish, recreational opportunities, and baseflow into the Colorado River. Reduction of or injury to these waters will affect Grand Canyon National Park and Havasupai Tribe resources.
3.8.4	24 of 52	"The proposed mining operations do not have the potential to impact groundwater." There is enough ambiguity about the presence, nature, and behavior of groundwater in this area that this statement cannot be made.
3.8.4	24 of 52	"Long-term subsurface contamination could potentially occur if contaminants reach deep groundwater aquifers." This statement is a direct contradiction to the statement above presented in the previous paragraph of the MDR.

Section	Page	Comment/Change
3.8.4	24 of 52	"No impacts to shallow aquifer springs are expected" Although claimed by the applicant that "drilling at the Wate project did not encounter aquifers or perched water" (MDR, p. 23), Arizona Department of Water Resources has a record from the Wate site from 2009 that encountered groundwater at 800ft. A records search confirmed that a diamond core borehole installed by Brown Drilling recorded a static water level of 800ft (ADWR Project Completion Report for well number 55-911015). Not only was this information neglected to be reported in the discussion of groundwater in the MDR, it contradicts assumptions that shallow groundwater either does not exist or will not be impacted. The large diameter mine workings can potentially act as large drains to these limited shallow groundwater resources. If a shallow aquifer is indeed present at this site, a monitoring (not supply) well should be installed to record potential draining of this aquifer system.
3.8.4	24 of 52	"Final underground development may extend to approximately 1,800ft. This is well above the minimum 2,000ft below surface depth of the R-aquifer." Ore-grade mineralization is known to exceed 1,900ft below surface at the Wate pipe (SRK, 2011), and may continue below this. Although plans are currently not to mine to this depth, increases in uranium prices during mining operations may make mining lower grade ore and/or deepening the shaft economically viable, bringing the total depth of mining operations closer to the regional water table.
3.8.4	24 of 52	"Water use by mine operations is limited." This needs to be better quantified, as reported estimates are contradictory. An interview in the Arizona Daily Sun (March 3, 2013) with a VANE representative stated that 10 acre-feet annually was needed (6.2 gpm). The MDR reports (p. 25) that a well producing 5 gpm will be sufficient, but then later (p.40), that 15,000 gallons/day will be necessary (10.4 gpm).

Section	Page	Comment/Change
3.8.5	25 of 52	BMPs for not only well installation but also for monitoring during and post-mining activities should be followed. The well should remain accessible post-reclamation for future sampling purposes.
3.11	27 of 52	Uranium ore should be added to the list of hazardous materials. Uranium ore is regulated as a Class 7 radioactive material under the USDOT hazardous material regulations (CFR 49 Part 173.403)
3.12	28 of 52	Uneconomic yet mineralized waste rock stockpiled at the site needs to be both placed on an impermeable enclosure and covered to prevent rain and snow from interacting with the ore and possibly leaching contaminants. By backfilling this material into the workings during site reclamation, a source of potential future contamination is being introduced. Although the material came out of this location, it was in a stable and likely reduced state. When backfilled, it will have been broken up, likely oxidized, and placed into workings with substantially higher hydraulic conductivities than the pre-mining state.
3.14	28 of 52	While the site is located within a Class II Airshed, it is within close proximity (~10 miles) to Grand Canyon National Park which is a Class I Airshed and subject to the highest air quality protections. Fugitive dust should be evaluated and addressed following the BMPs.

Section	Page	Comment/Change
3.16	29 of 52	Was the project evaluated for visual impacts from the North Rim of Grand Canyon National Park? The project has the potential for being visible from the North Rim. Coconino County Dark Sky ordinances should be referenced and evaluated to address potential impacts if operations are to occur at night. In addition, these impacts could adversely affect Grand Canyon National Park dark sky resources, especially from North Rim localities.
3.17	29 of 52	Portions of Grand Canyon National Park are less than 10 miles from the proposed mine. The Havasupai Reservation is 7.5 miles away and the Hualapai Reservation is only 2 miles away.
3.22.4	31 of 52	"There are no significant traffic issues anticipated due to the remoteness of the project and very light non-mine traffic." Indian Route 18 is the main access point to the village of Supai on the Havasupai Reservation, and is the main access point for tourism on both the Reservation and the National Park portion of Havasu Creek below.
3.24	31 of 52	"The Wate project is projected to have a positive socio-economic impact on the local area." While revenues from wages, taxes, etc. would add to the local economy, much of the economic gain from the mining, processing, and sale of uranium from this mine would be seen by the mill site (located out of State) and VANE Minerals (located out of Country). Additionally, economic benefits from this mine pale in comparison to the annual economic benefits of Grand Canyon National Park of $467 million (Cui and others, 2013).

Section	Page	Comment/Change
4.17	43 of 52	"Supply will be supplemented by water originating from underground workings." The applicant states that there is no shallow groundwater at the site, so there should not be any water accumulating in the workings that had originated from the subsurface.
5.2.2	47 of 52	While the upper portions of the shaft to the surface will be filled/plugged, large voids will remain either empty or backfilled with porous, potentially mineralized material. If shallow groundwater exists in the region, it will over time fill these voids, come into contact with the mineralized material, and could migrate off-site along the prevailing hydraulic gradient.
5.2.4	47 of 52	Inspection of the pond liner for evidence of leaking at the last stage of reclamation is too late in the process. Any evidence of leaking at this stage indicates that potential contamination may have been occurring to the subsurface for years. The applicant should install an automated leak detection system as referenced in the BMPs Water Resources section.
5.2.6	49 of 52	A radiological survey of the proposed mine site and surrounding areas should be conducted as outlined in the BMPs prior to developing the mine shaft and mineral extraction. Establishing what baseline conditions are will be essential to appraising the success of remediation efforts. Without these data, a during-remediation survey for areas above 10 mrem/yr will not give the full picture of how the site has been impacted by mining activities.

Section	Page	Comment/Change
5.6	51 of 52	Reclamation project costs can also vary greatly due to fluctuating prices of uranium. A substantial drop in prices may prompt the mine operator to place the mine on "standby" like the Canyon and Kanab North mines, not only causing the mine increased maintenance and monitoring costs, but also increasing the overall costs of site reclamation in the future due to inflation. Costs can also increase due to an increase in uranium prices as well. Increased prices may persuade the mine operators to increase the extent and depth of the mine workings following lower-grade ore, increasing the initial reclamation costs and increasing the chances of long-term legacy contamination that may be borne by the mine operator or the land owner depending on the timescale of impact.