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To Whom it May Concern:

One cannot overstate the importance of Ash Meadows National Wildlife Refuge (NWR). It is a unique ecological treasure, a recognized global biodiversity hotspot, and is home to the highest density of endemic species (found only at Ash Meadows and no place else) in the United States. The springs and groundwater resources are a critical part of the Amargosa River, an underground river that flows from Oasis Valley in Nevada to Badwater Basin in Death Valley National Park. Along the way, the Amargosa River appears on the surface as springs and pools which support an incredibly rich web of life in one of the hottest, driest places on Earth.

The Nature Conservancy is deeply invested in the conservation and protection of this place. In fact, Ash Meadows NWR was established on June 18, 1984 through a collaboration between The Nature Conservancy, US Bureau of Land Management (BLM), and the US Fish and Wildlife Service to protect and restore the many rare plants and animals found there.

In July 2023, The Nature Conservancy (TNC) took the rare action of issuing a press release in opposition to a proposed lithium exploration activity bordering the Refuge. It is highly unusual for TNC to publicly oppose projects. We took this action because of the potential catastrophic consequences that could result from exploratory drilling occurring so close to the springs and pools in the Refuge. These serious concerns were informed by a review of well logs that had been drilled in the area and a case study of an artesian flow that resulted in an area of similar hydrology within the Amargosa Basin. The well log and case study assessment were conducted by hydrology consultant Andy Zdon from Roux, Inc. and are included in the attachments to this memo.

The Nature Conservancy supports efforts to better buffer Ash Meadows NWR from threats to the groundwater resources and associated species. The local communities, tribes, and conservation groups have proposed a mineral withdrawal for the area around Ash Meadows. To better understand the need for and the resources that would be affected by a mineral withdrawal, TNC commissioned two additional studies. One study modeled the potential groundwater withdrawals and hydrologic impacts from a proposed lithium extraction project and the second study assessed the potential mineral commodities that would be affected by such a mineral withdrawal.

Attached to this letter are technical memos that summarize the results of hydrological modeling and minerals assessment. The hydrologic modeling indicates that mining activities near Ash Meadows could significantly and dramatically impact the groundwater flows that feed the springs in the refuge. For example, the model estimated a 20% reduction overall of spring discharge and evapotranspiration at Ash Meadows NWR if mine dewatering of 1,500 gallons per minute were to occur east of the Gravity Fault. The minerals assessment identified lithium, crushed stone, sand and gravel, and metallics as potential mineral commodities, with 3,000 existing mining claims within the boundary of the proposed mineral withdrawal study area. The goals of these studies were to provide the scientific background information to support the efforts to protect the springs and the species that depend on them at Ash Meadows NWR.

Thank you for your review of these technical memos. We welcome comments and questions, which can be directed to our Nevada external affairs director, Jaina Moan, jaina.moan@tnc.org.

Sincerely,

Mauricia M.M. Baca
State Director
The Nature Conservancy in Nevada

ROUX

Date: June 5, 2024

To: Jaina Moan – The Nature Conservancy

From: Andy Zdon, P.G., CEG, C.Hg and Dylan Bailey, Staff Geologist II

Subject: **Hydrologic Review related to Future Groundwater Extraction for Mining Purposes near Ash Meadows National Wildlife Refuge, Nye County, Nevada**

Roux Associates, Inc. (Roux) is pleased to provide The Nature Conservancy (TNC) with this Technical Memorandum (memo) summarizing our hydrogeologic review related to the proposed mineral withdrawal in the Ash Meadows National Wildlife Refuge (NWR) area of Nye County, Nevada. The proposed minerals withdrawal is part of an effort to provide hydrogeologic protections to the springs at Ash Meadows NWR and similarly the Devil's Hole unit of Death Valley National Park, Additionally, the proposed minerals withdrawal will be protective of the general groundwater resources of the Amargosa Desert hydrographic basin (Nevada 14-230). This region is hydrologically upgradient of the Shoshone-Tecopa portion of the Amargosa River in California, and hence protection of those resources will also be protective of the Amargosa Wild & Scenic River.

The hydrogeologic analysis described in this memorandum is part of a larger scope of work including reviewing and evaluating documents related to (1) the proposed Rover Critical Minerals Corporation (Rover) project, (2) the other mineral resource claims in the area, and (3) the geology and hydrology specific to the area. Additionally, a field trip with the modeler was conducted to provide a stronger foundation for the modeling using the United States Geological Survey's (USGS) Death Valley Regional Groundwater Flow System Model (DV3 model). The modeling analysis was conducted to provide insight into the extent of an area for a potential future minerals withdrawal providing protection for the groundwater regime feeding the NWR and its springs.

Summary

Roux evaluated hydrologic impacts based on a potential open pit of approximately 300 feet in depth in the proposed mine area footprint based on Rover's original exploratory drilling application. In order to evaluate the effect that our Rover example would have on the Ash Meadows NWR as a test case for the minerals withdrawal analysis, Roux used the DV3 model developed by Halford and Jackson (2020). The model currently provides the most robust tool for evaluating groundwater changes in the Amargosa Desert area. Roux conducted four simulations to anticipate the effects of dewatering from Rover's proposed open pit mining operation. The four simulations are described below.

- **Scenario 1** - A base simulation of dewatering in the West Claim block east of Gravity Fault. The simulation was run using six wells located at the eastern edge of the West Claim each pumping at 1,500 gallons per minute (gpm) for 10 years, 50 years, and 100 years (Note: A Theis solution check exercise assumes local mean properties for model layers 3 and 4 as a separate quality control and quality "order-of-magnitude" check).
- **Scenario 2** - Dewatering in the West Claim block west of the Gravity Fault with a total discharge of 2,000 gpm for 10 years around the perimeter of the West Claim block west of Gravity Fault to evaluate the effectiveness of the Gravity Fault as a barrier to drawdown propagation to the springs at the NWR that may occur from pumping to the west.
- **Scenario 3** - Dewatering in the East Claim block with a total discharge of 1,000 gpm for 10 years.

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- **Scenario** 4 - Reduced dewatering in the West Claim block east of Gravity Fault to achieve only 10 feet of dewatering (2,700 gpm for 10 years), followed by 10 years of recovery.

Roux also evaluated the reduction of drain features in the DV3 model in the Ash Meadows to evaluate the relative reduction in spring flow and evapotranspiration that would result from the base scenario of 9,000 gpm of dewatering for 10 years from the portion of the West Claim block east of the Gravity Fault.

Key takeaways from our modeling review are listed below.

- Based on Scenario 1, the DV3 model estimates a 20% reduction of spring discharge and evapotranspiration at Ash Meadows NWR.
- Based on Scenario 1 (9,000 gpm – full dewatering not achieved), the DV3 model predicts significant drawdown in the groundwater surface beneath the Ash Meadows NWR and Devil's Hole;
- Dewatering on the West Claim Block west of the Gravity Fault (Scenario 2) also produced drawdown to the east of the fault, although to a lesser extent than in Scenario 1, indicating that pumping west of the Gravity Fault may also impact Ash Meadows springs and Devil's Hole;
- Scenario 3, dewatering of the East Claim block to 300 feet, was accomplished at 1,000 gpm due to the low transmissivities present in the DV3 model. Due to those low transmissivities, drawdown was limited to the area of the claim block, with drawdown at Devil's Hole and Ash Meadows NWR springs predicted to be 0.1 feet or less;
- The reduced dewatering scenario (Scenario 4) to achieve 10 feet of dewatering the West Claim block east of the Gravity Fault, produced 3 feet of drawdown at Devil's Hole after 10 years and 1 to 2 feet of drawdown at Rogers, Point of Rocks, and Five Springs;
- After 10 years of recovery after the reduced dewatering ceases, the outer extent of the cone of depression continued to expand;
- The response to groundwater stresses such as those associated with the modeling scenarios would be rapid with effects at Devil's Hole and Ash Meadows NWR spring being substantially less than the 10 years simulated; and,
- Based on the example of the "Borehole" near Tecopa Hot Springs in similar hydrogeologic conditions as present in the proposed Rover project claim blocks, potential impacts may occur from minerals exploration drilling encountering saturated conditions under pressure that could impact Ash Meadows springs and Devil's Hole.

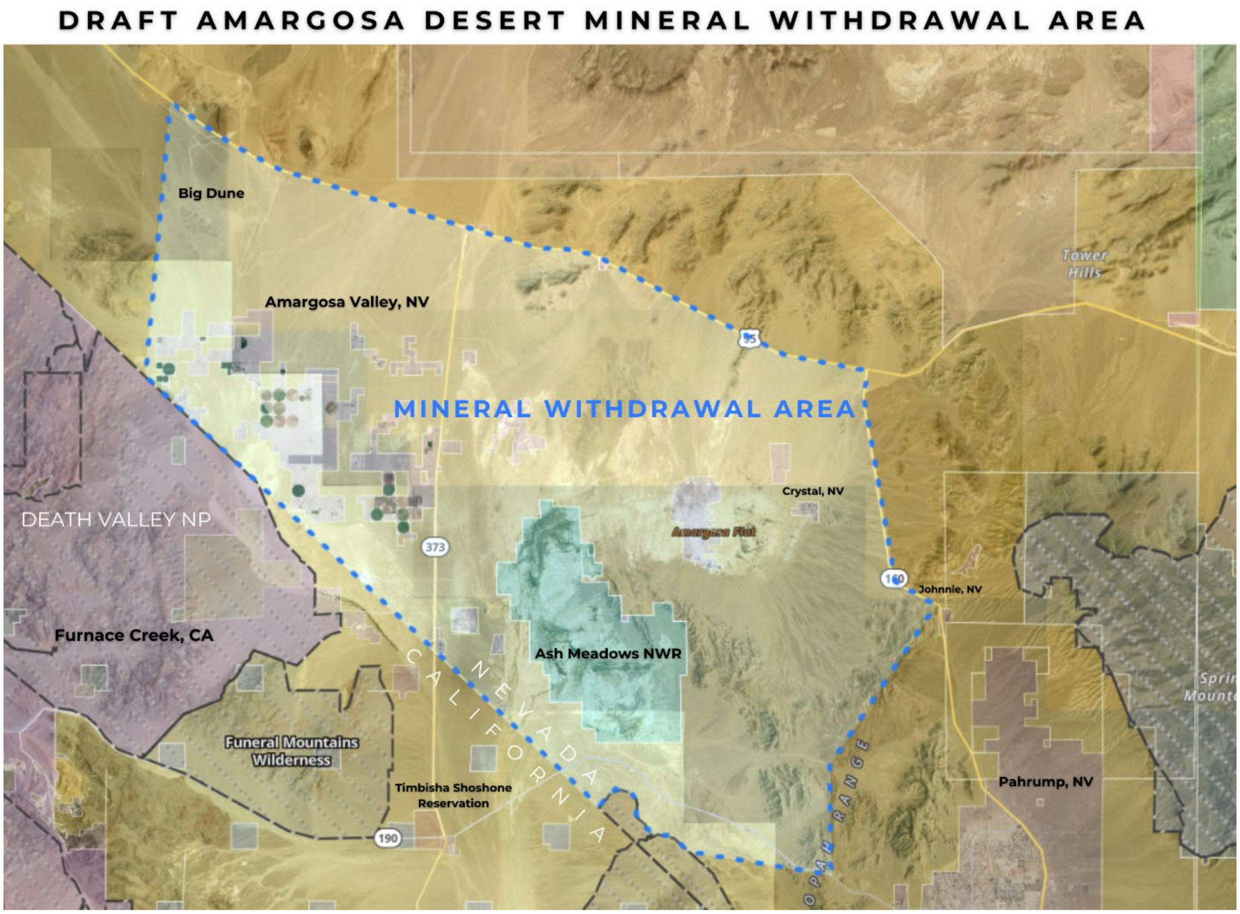
These results indicate that groundwater extraction and exploratory drilling related to minerals extraction in the area of Ash Meadows NWR and Devil's Hole will produce impacts to surface spring discharge and evapotranspiration. Further, although the Gravity Fault buffers impacts to Ash Meadows NWR (east of the fault) from pumping west of the fault, impacts to the Ash Meadows NWR area groundwater-dependent habitat remain likely.

Background

Ash Meadows NWR and the Devil's Hole Unit of Death Valley National Park are within the Amargosa Desert hydrographic basin 14-230 in Nye County, Nevada (see Figure 1 on following page). The Ash Meadows National Wildlife Refuge (Refuge) is noted as a groundwater discharge location in the Amargosa Desert Hydrographic Basin, within the Death Valley Regional Flow System, with numerous large springs and sensitive habitat for desert pupfish and numerous other Endangered Species Act (ESA) listed wildlife and plant species. Flow from the large springs in the Refuge is largely derived from the carbonate rock aquifer of the Death Valley Regional Flow System. Discharge from the carbonate rock aquifer in the Ash Meadows area occurs both directly, via spring discharges, and indirectly, via the shallow basin-fill aquifer, which in turn contributes to spring discharges. In other words, the shallow and deep aquifers in this region are hydrologically connected and both contribute flow to surface springs in the Ash Meadows NWR.

For the purposes of considering the perennial yield and existing underground (groundwater) rights, in this memo, the Amargosa Desert hydrographic basin has been lumped with other hydrographic basins (inclusive of basins #225 through #230) in the surrounding area. These other basins include Crater Flat, Oasis Valley, Mercury Valley, Rock Valley, Fortymile-Jackass Flat, and Fortymile Buckboard Mesa, respectively. The combined estimated perennial yield of these basins is 24,000-acre feet per year (afy), while the committed groundwater rights represent 25,635 afy, indicating an over-allocated area (Nevada Department of Water Resources, 2024).

Figure 1 – Location of Ash Meadows NWR and proposed mineral withdrawal area.

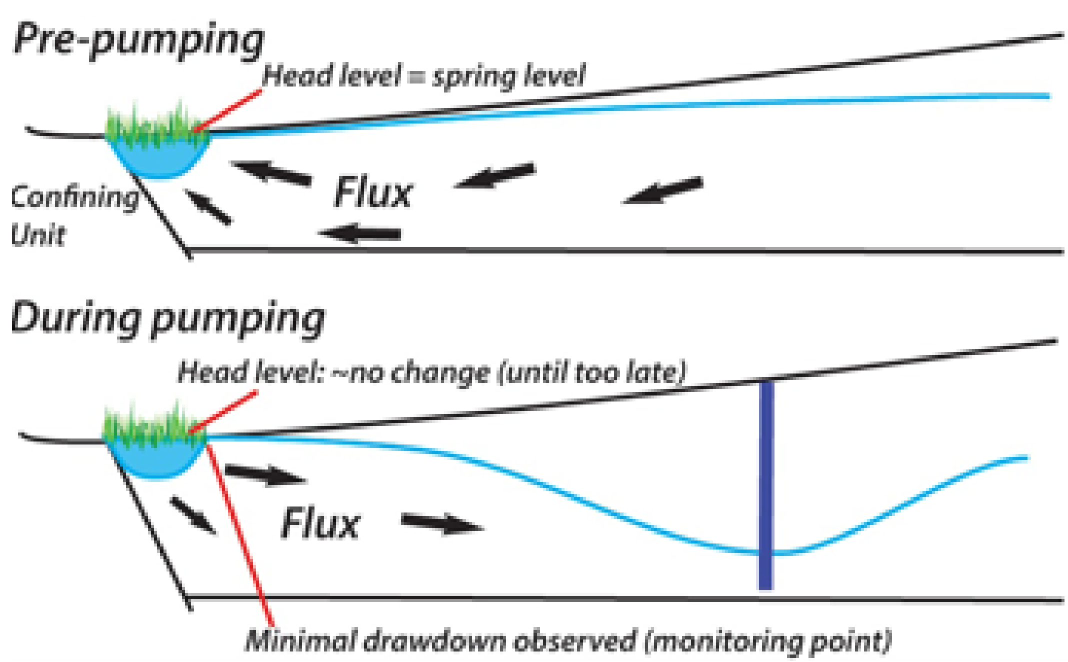


Rover has proposed to conduct mineral exploration drilling in the area north of, and immediately adjacent to the Ash Meadows NWR. The Rover Project consists of two claim blocks immediately north of Ash Meadows NWR (the West Claim, and East Claim Blocks, respectively). Should that exploration indicate future mining operations are feasible, it would be anticipated that open-pit mining would occur at those locations. Groundwater conditions within the aquifer beneath those claim blocks is artesian. Therefore, substantial dewatering would need to take place for mining to occur, potentially putting Ash Meadows NWR springs and neighboring Devil’s Hole at risk. Although this memo is not a technical review of the Rover Project (and should not be used specifically for that purpose), it is used as a test example to evaluate how, and to what extent, potential groundwater extraction in the area of these claim blocks would affect the Ash Meadows area. Additionally, the Rover Project test case is used to test the Gravity Fault, a north-south trending geologic fault running through the area, as a potential barrier to impacts from pumping west of Ash Meadows NWR.

What are springs and how can pumping impact them?

Springs are places where groundwater reaches the ground surface, discharging as surface flow. By nature of their character, springs are sensitive to changes in groundwater level. For some springs, small changes (<1ft) in groundwater elevation can result in the difference between surface water flow being present or absent. Some springs are small, seasonal, locally perched features where last year's rainfall that soaked into the ground has hit a barrier to its downhill flow path, forcing that water back to the ground surface. The discharge from these local springs is gravity driven. Other springs are tied to deeper and more distant groundwater flow paths that may extend well beyond the boundaries of the local watershed. This is the case for Devil's Hole and the springs at Ash Meadows NWR. Because these flow paths are deeper, they are generally not affected by seasonal rainfall or changes in air temperature, they usually have more consistent flow, and if the flow paths are sufficiently deep, they are characterized by warmer groundwater discharge temperatures that remain relatively consistent over time and may be thermal. These springs will commonly have discharges that are anomalously large for their limited topographic watershed and local precipitation. These latter springs often rise to the surface under pressure, commonly referred to as artesian groundwater. Artesian wells then are wells that discharge waters from confined aquifers in which the groundwater level is above ground surface. Groundwater pumping or discharges from artesian wells decrease the head on the springs (drawdown), resulting in a corresponding decrease in spring flow. Figure 2 presents an example schematic of this relationship. Taken to its endpoint with continued pumping, the head level in the figure would eventually decrease, and surface discharge could cease to occur.

Figure 2. Spring flow capture from groundwater pumping (adapted from Currell, 2016)



In Ash Meadows NWR and the surrounding area, the primary risk to springs is the potential impacts due to regional pumping. In the case of pumping due to future mining projects (e.g., the test example Rover Project operation north of Ash Meadows NWR), the effects of pumping would be additive (superimposed) on the effects of existing regional pumping. As described earlier, the proximity of the groundwater extraction to support future mining close to the Ash Meadows area to springs and neighboring basin-fill aquifers is likely to have a deleterious effect. In Ash Meadows NWR, these effects are likely to result in decreased groundwater elevation (drawdown), local changes to hydraulic gradients (horizontal and vertical gradient-directions), reductions in spring discharge, and decreased evapotranspiration.

Spring impacts due to pumping in the Ash Meadows area go back to 1968, when a nearby ranch began pumping groundwater for agricultural purposes, causing the water level in Devil’s Hole to drop. This decrease in groundwater head at Devil’s Hole put the resident pupfish at risk and ultimately led to litigation that resulted in the Cappaert Decision. The Cappaert Decision put a hold on groundwater pumping that would lower the water below a depth necessary to preserve the pupfish, and established Devil’s Hole as a national monument (now a unit of Death Valley National Park).

Hydrogeologic Characteristics of the Ash Meadows Area

The following description of the hydrogeologic characteristics of the Ash Meadows NWR and Devil’s Hole area is largely paraphrased from Laczniak, et.al. (1999). The groundwater-dependent ecosystems at Ash Meadows NWR and Devil’s Hole are a result of the area's unique hydrogeology. The many springs and shallow water table in the area are maintained primarily by groundwater that moves into the area from the north and northeast through a thick, semi-continuous carbonate-rock aquifer system. Groundwater moving through this aquifer originates from precipitation falling on the higher mountain ranges and mesas throughout an area that extends hundreds of miles to the north and east. Along the flowpath from source to discharge point, carbonate-rock units carrying most of the groundwater are buried by thick accumulations of sediments that make up the basin fill.

At Ash Meadows, the groundwater flow is impeded by a generally northwest to north trending fault zone termed the “Gravity Fault” (Laczniak, 1999). The Gravity Fault causes an abrupt change in hydraulic characteristics with higher transmissivity, faulted and fractured carbonate-rock to the east, and the less transmissive fine-grained lakebed sediments and generally coarser alluvial basin-fill sediments to the west. That change in hydraulic characteristics forces groundwater flow to the surface in the form of the Ash Meadows springs and Devil’s Hole. A geologic map of the area of the proposed mineral withdrawal inclusive of the Ash Meadows area is on Figure 3 on the following page.

Groundwater movement toward Ash Meadows and Devil’s Hole is largely controlled by a large, highly transmissive zone of the carbonate aquifer that extends from the Ash Meadows area on the west, northeastward toward Yucca Flat and Mercury, Nevada. This is represented in the Figure 4 which follows showing the transmissivity of aquifer materials as represented in the DV3 model (from Halford and Jackson, 2020).

Figure 3. Study Area Geologic Map (adapted from Workman, et.al., Laczniak, et.al., 1999)

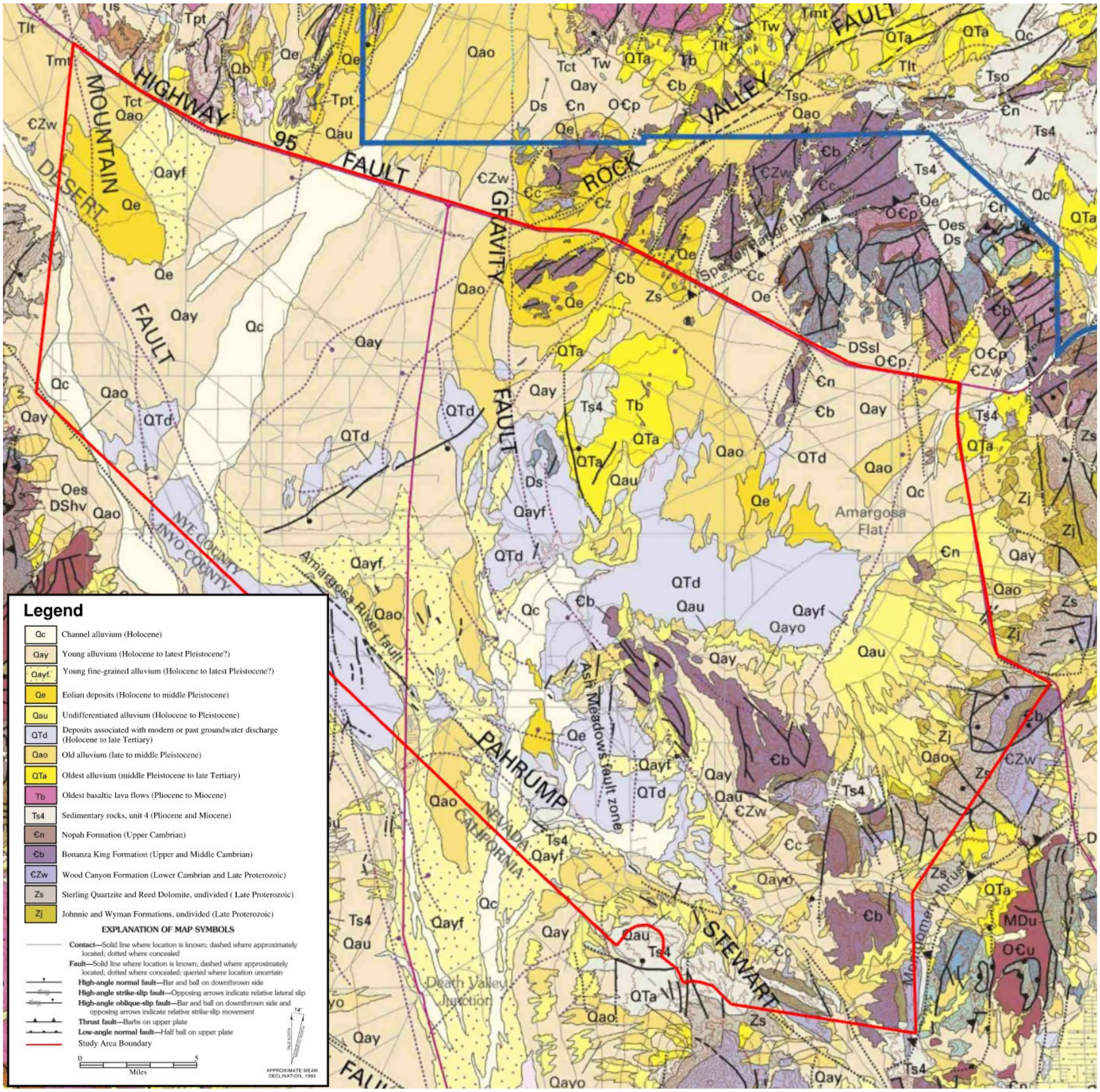
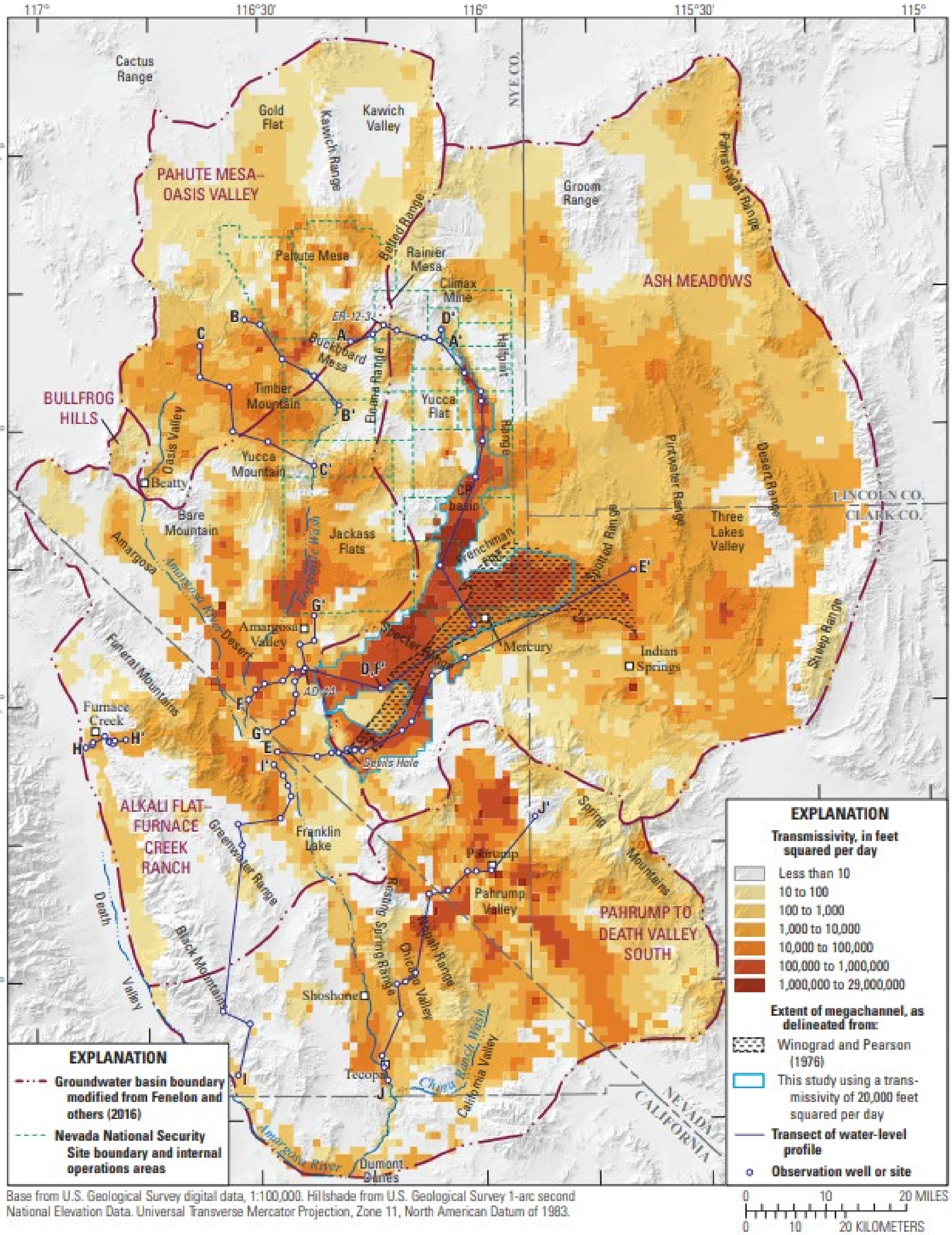


Figure 4. Transmissivity Distribution in Aquifer Materials (Halford and Jackson, 2020).



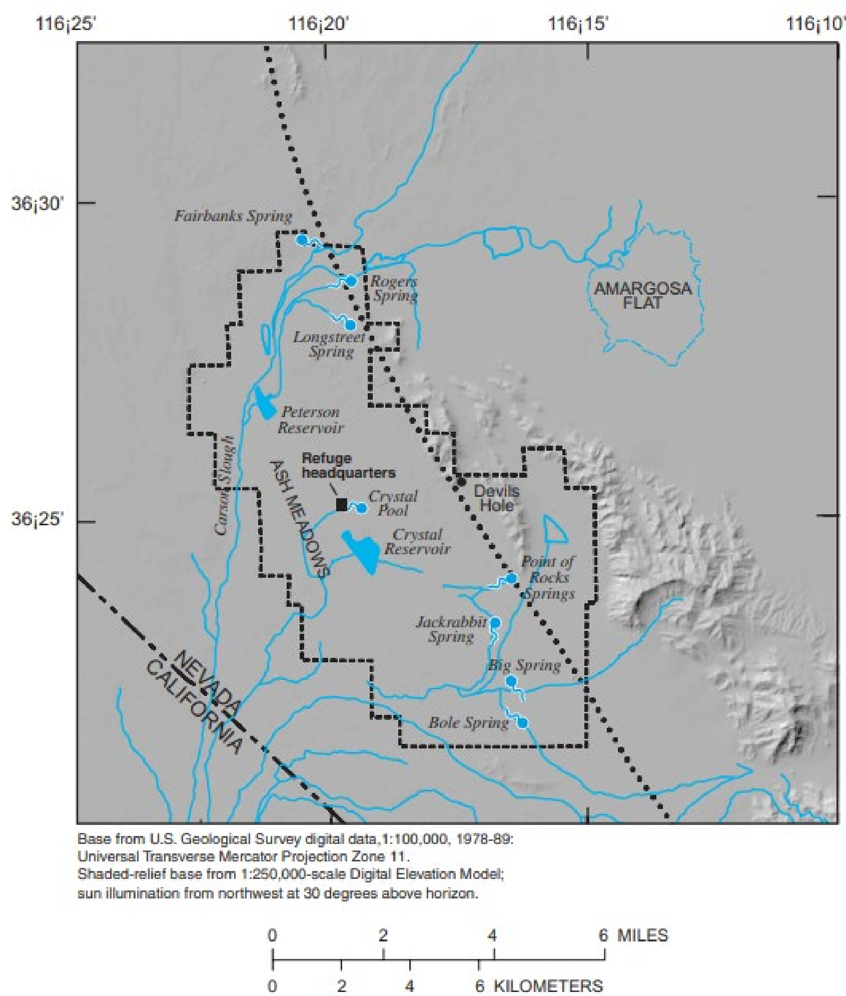
Ash Meadows / Devil's Hole Area Springs

For the purposes of this evaluation, Roux focused on the following springs in the area:

- Devil's Hole;
- Fairbanks Spring;
- Longstreet Spring;
- Rogers Spring;
- Five Springs;
- Point of Rocks Spring;
- Crystal Pool;
- Jackrabbit Spring; and
- Big Spring.

The relative locations of these features are provided in Figure 5.

Figure 5. Ash Meadows NWR Area Springs (Laczniak, et.al., 1999)



Devil's Hole is within an isolated unit of Death Valley National Park adjacent to Ash Meadows NWR and to the east. Unlike the springs in Ash Meadows that discharge large volumes of groundwater (more than 10,000 gpm combined), water at Devil's Hole is present in a carbonate-rock grotto. Free-flowing discharge across the land surface does not occur at this location. It is best known for being the habitat for the only population of the endangered Devil's Hole Pupfish (*Cyprinodon diabolis*). Water levels at Devils Hole are to be maintained at or above a minimum pool level due to the 1976 U.S. Supreme Court decision on *Cappaert v. United States* described earlier. Devil's Hole, and the springs at Ash Meadows that follow below have their waters tied to the high transmissivity zone shown in Figure 4. Groundwater withdrawals for mining activities such as pit dewatering, or that encounter artesian flow from that zone resulting from exploratory drilling could impact Devil's Hole and the springs at Ash Meadows.

The springs at Ash Meadows NWR discharge about 10,500 gpm. Fairbanks Spring is immediately south of the northern boundary of Ash Meadows NWR (Figure 6). It is approximately 1,000 feet from the nearest planned exploratory borehole for the Rover Project. Fairbanks Spring discharges at approximately 1,600 gpm (USGS, 2024).

Figure 6. Fairbanks Spring

Other springs that discharge more than 500 gpm in the Ash Meadows NWR include Rogers Spring, Longstreet Spring, Crystal Pool (approximately 2,800 gpm), Point of Rocks Spring (approximately 2,900 gpm), Big Spring (approximately 1,300 gpm), and Jackrabbit Spring (approximately 600 gpm) (USGS, 2024). Photographs of Rogers Spring and Point of Rocks Spring are provided below (Figures 7 and 8).

Figure 7. Rogers Spring

Figure 8. Point of Rocks Spring

Sustainability of Groundwater Systems

The volume of groundwater in storage is an important aspect of the groundwater system. Changes in storage are observed in the field by changes in groundwater levels. A fundamental groundwater equation and the basis for evaluations of groundwater budgets (inflow vs. outflow estimates) is:

Inflow – Outflow = Change in Storage

When outflow exceeds inflow, there is a negative change of groundwater in storage and groundwater levels can be expected to decline. When inflow exceeds outflow, the reverse is true. When the system is in equilibrium, water levels will generally remain relatively constant despite short-term fluctuations. For the purposes of this evaluation, in the Ash Meadows NWR, we evaluated changes to the system based on existing conditions. The Ash Meadows NWR has seven major springs that discharge at more than 500 gpm and 25 other minor springs that discharge at less than 500 gpm. In total the combined springs discharge an average of 23.5 cubic feet per second (cfs) or around 10,500 gpm (Mayer, 1997).

It follows then, that when a groundwater system such as at the NWR is in equilibrium where inflow equals outflow, groundwater levels will be stable. However, groundwater pumping such as that proposed for the Rover Project (our test case used for this analysis), mine dewatering or other groundwater extraction would cause a disruption in this equilibrium, and cause changes in the aquifer system. These changes could include reducing discharge components like spring discharge and evapotranspiration in areas of shallow groundwater, or by inducing additional underflow from more distant parts of the aquifer system.

Regardless of the amount of groundwater pumped, there will always be groundwater drawdown (and the removal of water from storage) in the vicinity of pumping wells, a necessity to induce the flow of groundwater to said wells. This area of groundwater drawdown is referred to as a cone of depression. For most groundwater systems, the change in storage in response to pumping is a transient phenomenon that occurs as the system readjusts to the pumping stress. The relative contributions of changes in storage, increases in recharge, and decreases in natural discharge evolve over time. The timing of that evolution in natural discharge change can be difficult to predict. If the system can come to a new equilibrium (i.e., a combination of increased recharge and/or decreased discharge), the storage decreases will stop, and inflow will again equal outflow with the changes to the inflow/outflow components (capture) described above. This is also described in the text above regarding how groundwater extraction can capture spring flow. The amount of groundwater “available” for a future groundwater extraction by a mining operation for example, is therefore dependent on what these long-term changes are, and how these changes affect the water resources and groundwater-dependent environmental resources of the area.

Hydrologic Analysis

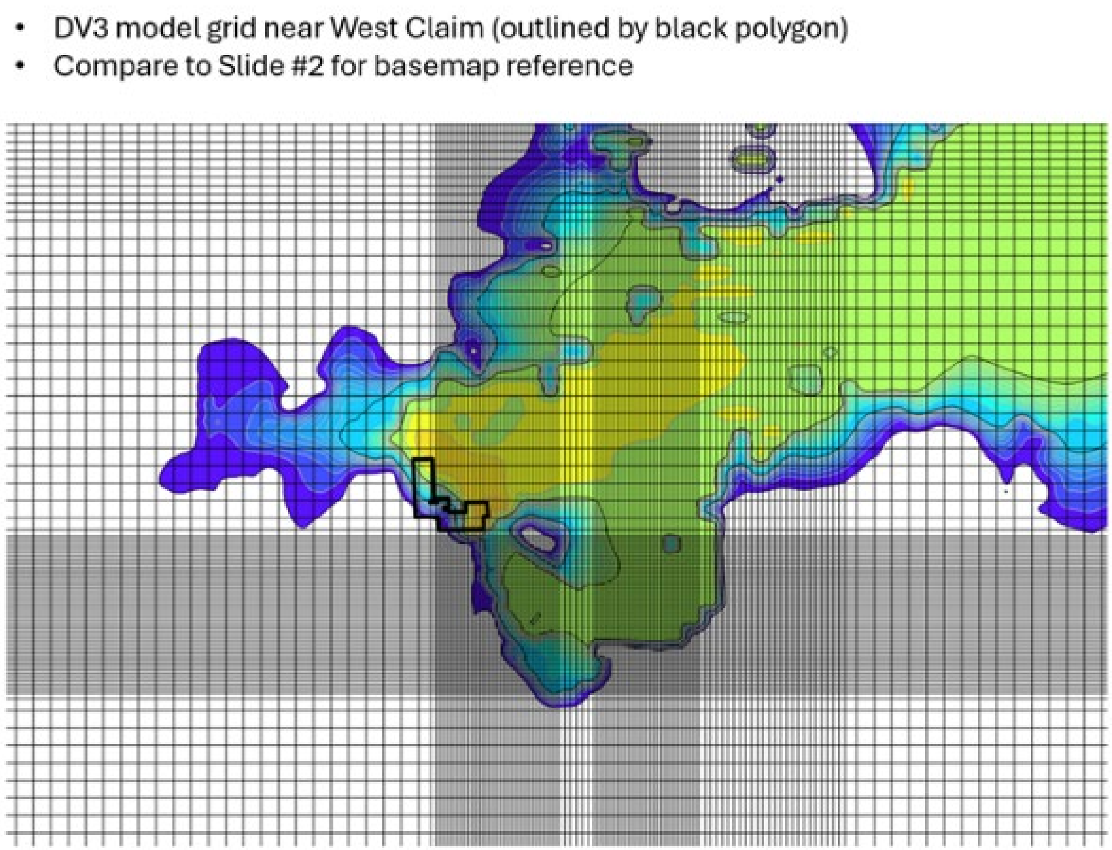
Roux reviewed many technical documents related to the proposed minerals withdrawal and the hydrogeology of Ash Meadows NWR and the surrounding area. These included those produced by the U.S. Geological Survey, State of Nevada, and others. As previously discussed, to evaluate the effect that our Rover example would have on the Ash Meadows NWR as a test case for the minerals withdrawal analysis, Roux used the DV3 model developed by Halford and Jackson (2020). The model currently provides the most robust tool for evaluating groundwater changes in the Amargosa Desert area. Given the construction of the DV3 model, the use of the model provides results (e.g., drawdown) that are relative to existing conditions and water fluxes are not absolute values but changes from “predevelopment” conditions. Additionally, as a result of this model construction, identifying specific changes in discharge from specific springs is problematic. However, since spring discharge is driven by head (the energy in the aquifer system produced by elevation or pressure for instance), inferences regarding relative impacts to specific springs can be made based on drawdown at those locations.

Use of the DV3 Model

The DV3 model was used by Roux to estimate hydrological responses to the proposed minerals withdrawal. The model was used to estimate the drawdown from the springs at Ash Meadows NWR and similarly Devil's Hole (Death Valley National Park), as well as the general groundwater resources of the Amargosa Desert hydrographic basin (Nevada 14-230).

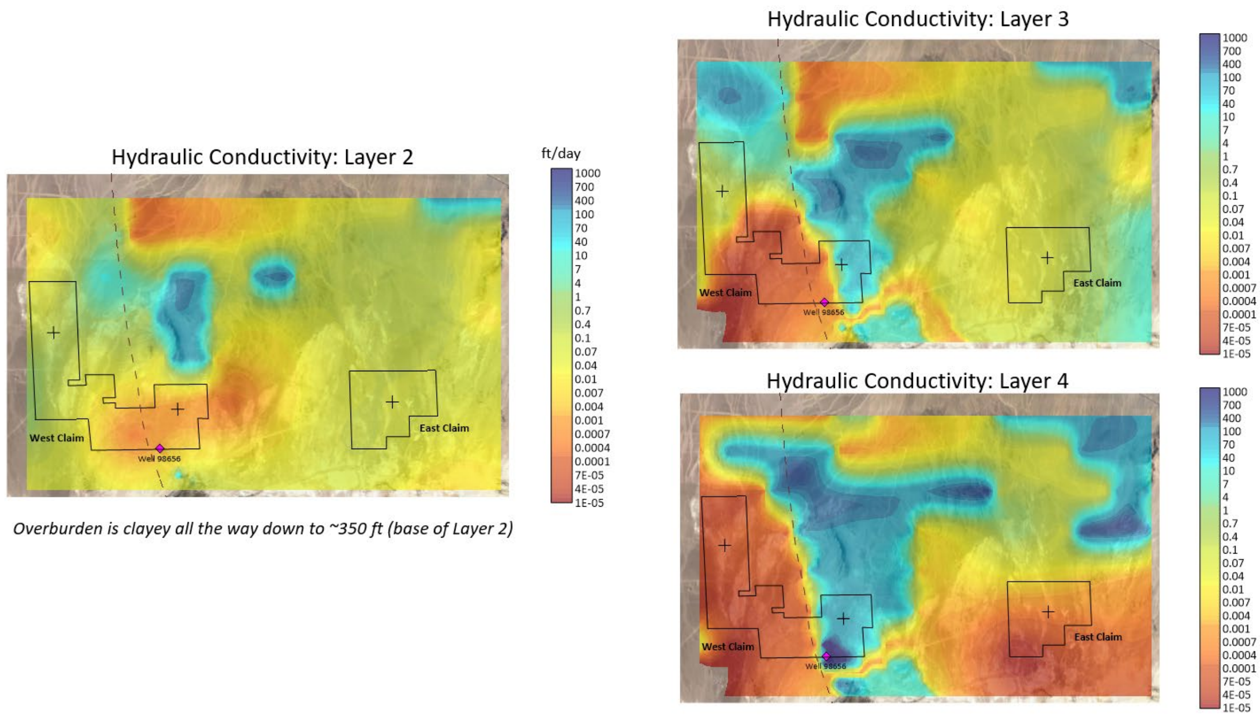
The DV3 model has a unique construction, constrained by "capture-limited discharge." There is a steady-state, pre-development baseline model and a "predictive" model that simulates deviations from the steady-state head distribution by superposition. The initial head in the predictive model is equal to zero everywhere, since it does not matter in this context; only the changes in head are evaluated. Roux's approach was to replace the hydraulic properties in the model in the 3-D space filled by the "Rover open pit" with high conductivity/high storage earth material. The first active layer in the model near the West and East Claims is about 300 feet thick. The model grid is refined within the Rover claim area and Ash Meadows NWR springs to provide greater resolution to the analysis as shown in Figure 9 below (Halford and Jackson, 2020).

Figure 9. DV3 Model Grid Refinement in Ash Meadows Area



The anticipated scenarios considered are the effects of dewatering a potential open pit of approximately 300 feet in depth in the proposed mine area footprint based on Rover's original exploratory drilling application. Figure 10 shows the orientation of the Rover claim blocks overlain on aquifer transmissivity of Layer 3 of the DV3 model (the model layer from which pumping is assumed to occur). Hydraulic conductivities are presented in units of feet per day.

Figure 10. Rover Claim Blocks and Aquifer Transmissivity



The Rover Project was used as a test scenario for the purposes of evaluating responses to dewatering in relation to Ash Meadows. The test scenario in this memo was not intended to be an impact analysis for any future proposed Rover Project and should not be used for that purpose. Within the west claim block, an artesian monitoring well was installed by USGS with screened openings approximately 350 feet below ground surface forming (along with Rover Project information) the basis for our proposed analysis. A well drilling log and associated technical memorandum related to that monitoring well are provided as Attachment A. As discussed, Roux conducted four simulations to anticipate the effects of dewatering from Rover's proposed open pit mining operation.

Roux also evaluated the reduction of drain features in the DV3 model in the Ash Meadows to evaluate the relative reduction in spring flow and evapotranspiration that would result from the base scenario of 9,000 gpm of dewatering for 10 years from the portion of the West Claim block east of the Gravity Fault.

<u>*Modeling Results*</u>

The substantial volumes of water pumped in the scenarios were model generated to achieve differing levels of drawdown. The initial dewatering goal was lowering the water table 300 feet. However, this was only achieved in Scenario 2 that involved dewatering in the West Claim block west of the Gravity Fault and Scenario 3 that involved dewatering for the East Claim block. The implications of this is described in the conclusions section of this memo. To summarize, the following simulations were conducted using the DV3 model:

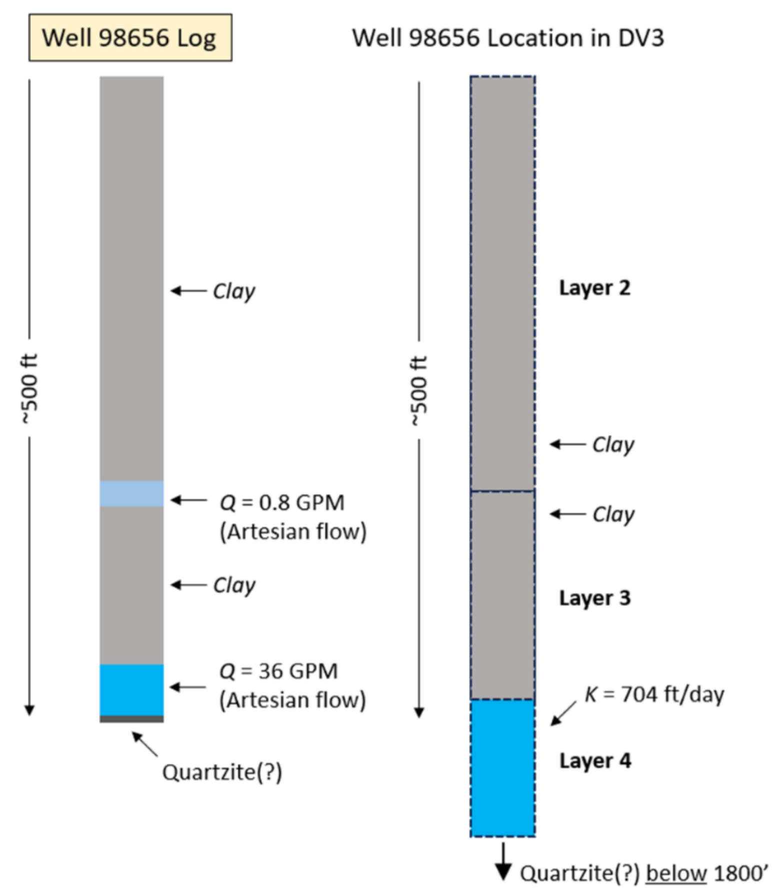
- **Scenario 1** - A base simulation of dewatering in the West Claim block east of Gravity Fault. The simulation was run using six wells located at the eastern edge of the West Claim each pumping at 1,500 gallons per minute (gpm) for 10 years, 50 years, and 100 years (Note: A Theis solution check exercise assumes local mean properties for model layers 3 and 4 as a separate quality control and quality "order-of-magnitude" check).

- **Scenario 2** - Dewatering in the West Claim block west of the Gravity Fault with a total discharge of 2,000 gpm for 10 years; around the perimeter of the West Claim block west of Gravity Fault to evaluate the effectiveness of Gravity Fault as a barrier to drawdown propagation to the springs at the NWR that may occur from pumping to the west.
- **Scenario 3** - Dewatering in the East Claim block with a total discharge of 1,000 gpm for 10 years.
- **Scenario** 4 - Reduced dewatering in the West Claim block east of Gravity Fault to achieve only 10 feet of dewatering (2,700 gpm for 10 years), followed by 10 years of recovery.

The expansive regional drawdown generally follows the zone of remarkably high transmissivity that extends northeastward from the Ash Meadows area. These high transmissivities are assumed to correspond with the lower carbonate aquifer (see Figure 4 in this memo).

Of note, is that the thickness of the carbonate-rock aquifer as observed in the USGS monitoring well is substantially thinner than that simulated in the DV3 model at that location. This would have the effect of substantially increasing the transmissivity in the model compared to what was observed in the monitoring well (Figure 11). However, variations in thickness of the carbonate aquifer, particularly in the area of the Gravity Fault may vary, and this represents an uncertainty in the analysis.

Figure 11. Variation of Carbonate Rock Thickness between DV3 Model and USGS Monitoring Well



With respect to the scenario times, Roux ran 10-year, 50-year, and 100-year scenarios for Scenario 1. Due to the high transmissivity and lower storage terms, drawdown at key features such as Devil's Hole or springs at Ash Meadows NWR could see drawdown substantially sooner than a 10-year period.

Scenario 1

Based on Scenario 1, simulating six wells east of gravity fault, and at the eastern edge of the West Claim (pumping a total of 9,000 gpm from layer 3 of the model (the most transmissive layer) for 10 years), the DV3 model estimates a 20% reduction of spring discharge and evapotranspiration at Ash Meadows NWR. Regarding drawdown, the DV3 model predicts approximately 50 feet of drawdown in the vicinity of the dewatering wells with a drawdown of 2 to 30 feet within the NWR and extending toward Mercury, Nevada (beyond the Amargosa Desert hydrographic basin). The drawdown distribution for Scenario 1 for 10 years and 100 years are presented in Attachments A and B, respectively. Drawdown in Layer 3 of the DV3 model (pumping layer) at key feature locations includes the following.

- Devil's Hole – 10 feet of drawdown;
- Five Springs – 10 feet of drawdown;
- Rogers Spring – 3 feet of drawdown; and,
- Longstreet, Point of Rocks, Jackrabbit and Big Springs - 1 to 3 feet of drawdown.

The 50-year and 100-year simulations show continued growth of the cone of depression. For example, drawdown at Devil's Hole were 23 feet and 30 feet for the 50-year and 100-year simulations, respectively. With respect to Fairbanks Spring, which is the closest spring to the West Claim block, 1 to 2 feet of drawdown were identified in the 50 and 100-year scenarios, respectively. This anomalous result (due to proximity of dewatering) is driven by the aquifer transmissivity in the DV3 model at that precise location and may not accurately represent what spring effects could occur at that location.

Scenario 2

Based on the Scenario 2 simulation, the DV3 model predicts approximately 300 feet of drawdown within the Rover Project mining pit indicating that the dewatering in that location could be accomplished. Of note is that the cone of depression continues to extend substantially to the east. Drawdown to the east of the fault, although to a lesser extent than in Scenario 1 (Attachment C) is present. One foot of drawdown was identified at Devil's Hole 10 years after dewatering started.

Scenario 3

Dewatering of the East Claim block to 300 feet was accomplished at 1,000 gpm due to the low transmissivities present in the DV3 model. Due to those low transmissivities, drawdown was limited to the area of the claim block, with drawdown at Devil's Hole and Ash Meadows Springs predicted to be 0.1 feet or less (figure not provided).

Scenario 4

The reduced dewatering scenario (Scenario 4) to achieve 10 feet of dewatering the West Claim block east of the Gravity Fault, produced 3 feet of drawdown at Devil's Hole after 10 years and 1 to 2 feet of drawdown at Rogers, Point of Rocks, and Five Springs (Attachment D).

Of note is that after 10 years of recovery while the pumping area recovered, the outer extent of the cone of depression continued to expand. Residual drawdown after 10 years of recovery is presented in Attachment E. Table 1 presents the drawdowns for the springs and points of interest at and around the Ash Meadows NWR for each of the scenarios.

Table 1. Simulated Drawdown, Ash Meadows Springs, Devil's Hole, and Surrounding Features

Spring/Well Name	Drawdown (ft) - West Claim Block - *East of Gravity Fault* (10 Years - 9,000 gpm) - achieve ~50 ft pit dewatering	Drawdown (ft) - West Claim Block *East of Gravity* - 50 Years (9,000 gpm)	Drawdown (ft) - West Claim Block *East of Gravity* - 100 years (9000 gpm)	Drawdown (ft) - West Claim Block - *West of Gravity Fault* (10 Years 2,000 gpm) - achieve ~300 ft Dewatering	Minimal Dewatering West Claim Block - East of Gravity Fault- 10 yrs - 10ft of pit drawdown (2,700 GPM)	Residual Drawdown (ft) - 10 Years after Minimal Dewatering
Fairbanks Spring	0.3	1	2	<0.1	0.3	<0.5
Rogers Spring	3	6	9	0.1	2	<0.5
Longstreet Spring	1	3	5	<0.1	1	<0.5
Crystal Pool	<0.1	0.3	0.7	<0.1	<0.1	<0.5
Point of Rocks Spring	2	6	9	0.1	2	<0.5
Five Springs	10	20	30	0.7	10	1
Jackrabbit Spring	1	4	7	<0.1	1	<0.5
Big Spring	2	3	6	<0.1	1	<0.5
Devil's Hole	10	20	30	0.6	10	1
Amargosa Valley Park	1	4	7	<0.1	1	<0.5
Indian Springs, Nevada	nm	4	7	nm	nm	nm
Amargosa Valley @ Hwy 95	<0.1	0.7	3	<0.1	<0.1	<0.5
Johnnie, Nevada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5
Mercury, Nevada	10	30	40	1	10	2

Notes:

Latitude and longitude shown in WGS84

ft = feet

< = less than

-- = not available

nm = not measured

Conclusions

Based on the results of the analyses, the key takeaways from this modeling evaluation are summarized in this section. The drawdown predicted in the scenarios presented in this memorandum will be additive to existing groundwater level declines that have been noted in the area.

With respect to exploratory drilling in the area, mineral exploratory drilling in similar geologic conditions adjacent to regional spring areas occurred further south in the Amargosa Basin near Tecopa Hot Springs, California. In 1967, the Stauffer Chemical Company conducted drilling in similar hydrogeologic conditions (see Attachment 2). That drilling resulted in what is now termed "the Borehole." The Borehole was initially an exploratory drill-hole that encountered water under pressure at a depth of approximately 360 feet (Partner Engineering and Science, 2020). Attempts were made to plug the boring using conventional methods, but water kept surfacing around each successive well seal, which also had the effect of creating a large void at depth. Attempts to seal the well were abandoned and what is known as "Borehole Spring" came into being. Creation of the Borehole partially depressurized the spring field surrounding Tecopa Hot Springs. This decrease in pressure lowered groundwater levels and reduced spring discharge in the surrounding area.

The Borehole example demonstrates that shallow drilling in the Amargosa Basin groundwater system, in similar conditions to those in the area of Ash Meadows, can have unpredictable and far-reaching hydrologic impacts. It further demonstrates that impacts to a groundwater system following drilling that encounters the aquifer are often iterative in nature, meaning that human interventions to reverse the impacts do not reestablish natural conditions but instead lead to further changes in the system and can present additional risk to sensitive groundwater dependent resources.

As presented above, the dewatering needed for the proposed mineral extraction covering the proposed would place a substantial stress on an already over-allocated groundwater system. The impacts of the mine-dewatering test case (i.e., Rover Project) considered in this analysis would affect Ash Meadows NWR springs and Devil's Hole. This is because the principal groundwater capture zone for the test mine dewatering, is the same high transmissivity zone from which the Ash Meadows springs are simulated in the DV3 model to discharge groundwater as described above. Further, given the issues with representing pumping in the West and East Claim as described earlier in this memo, and the complex nature of the geology represented in that portion of the DV3 model, the results presented should be framed as estimates with significant uncertainty. That uncertainty results in a degree of risk in water management decision-making related to the future water extractions applications and their incremental impacts on an already stressed groundwater system.

Based on the results of Scenario 2, assuming pumping solely west of the Gravity Fault, it appears that the Gravity Fault does not provide a fully-effective barrier limiting impacts to Ash Meadows from pumping west of the fault, as drawdown east of the fault was only partially mitigated. Uncertainties associated with spatial variation of high transmissivity zones laterally and vertically add uncertainty and additional risk.

With respect to timing of impacts due to test case pumping, the model indicates that the response to groundwater stresses such as those associated with the modeling scenarios would be rapid with effects at Devil's Hole and Ash Meadows NWR spring being substantially sooner than the 10 years simulated. This is a result of the combined confined conditions of the aquifer system, and the remarkably high transmissivity associated with geologic units feeding the Ash Meadows springs as simulated in the DV3 model. Additionally, due to the lag in regional groundwater-level recovery after pumping ceases, the extent of the limits of the groundwater cone of depression could continue to expand and deepen longer after groundwater extraction ceases and recovery occurs in proximity to the pumping.

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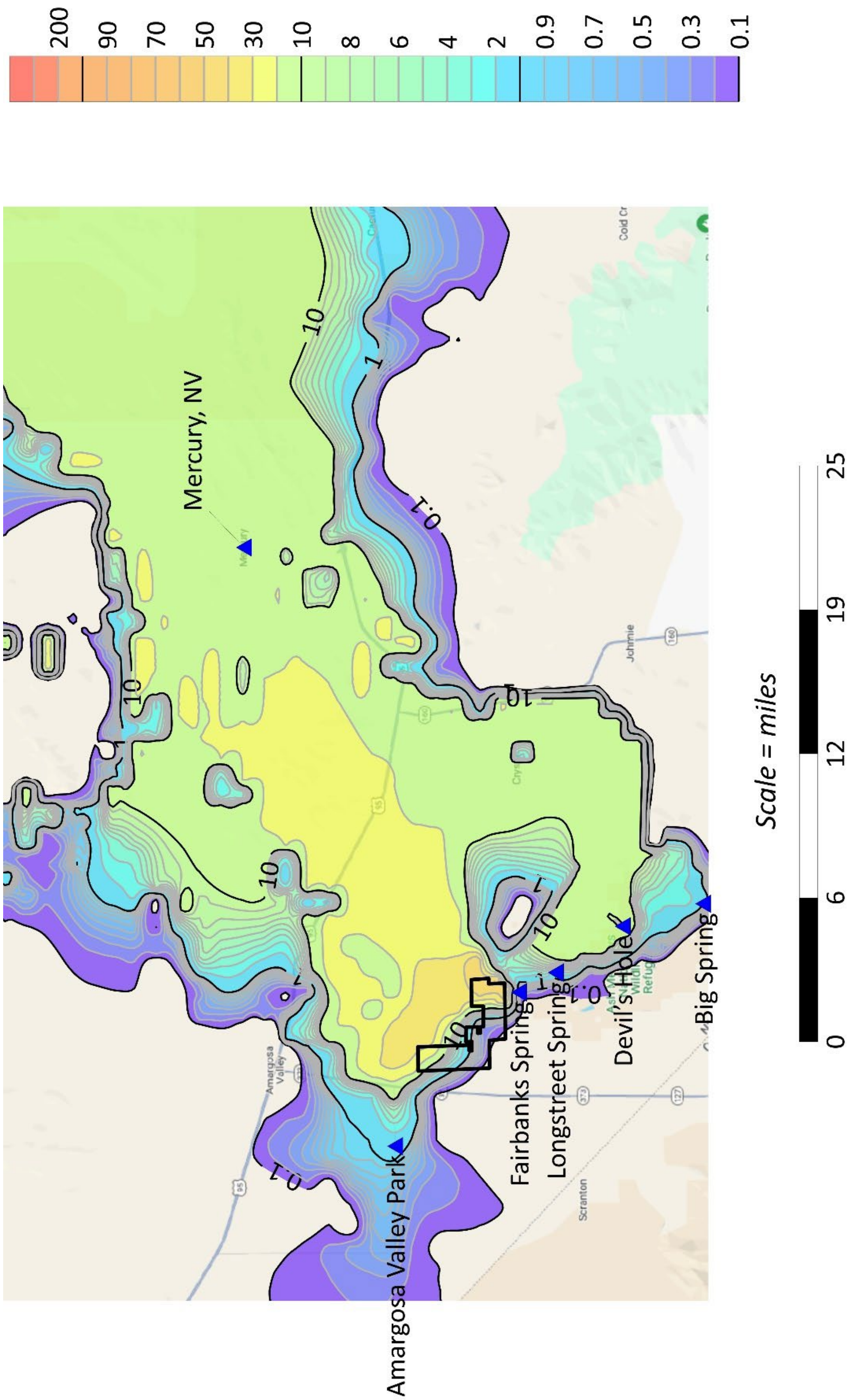
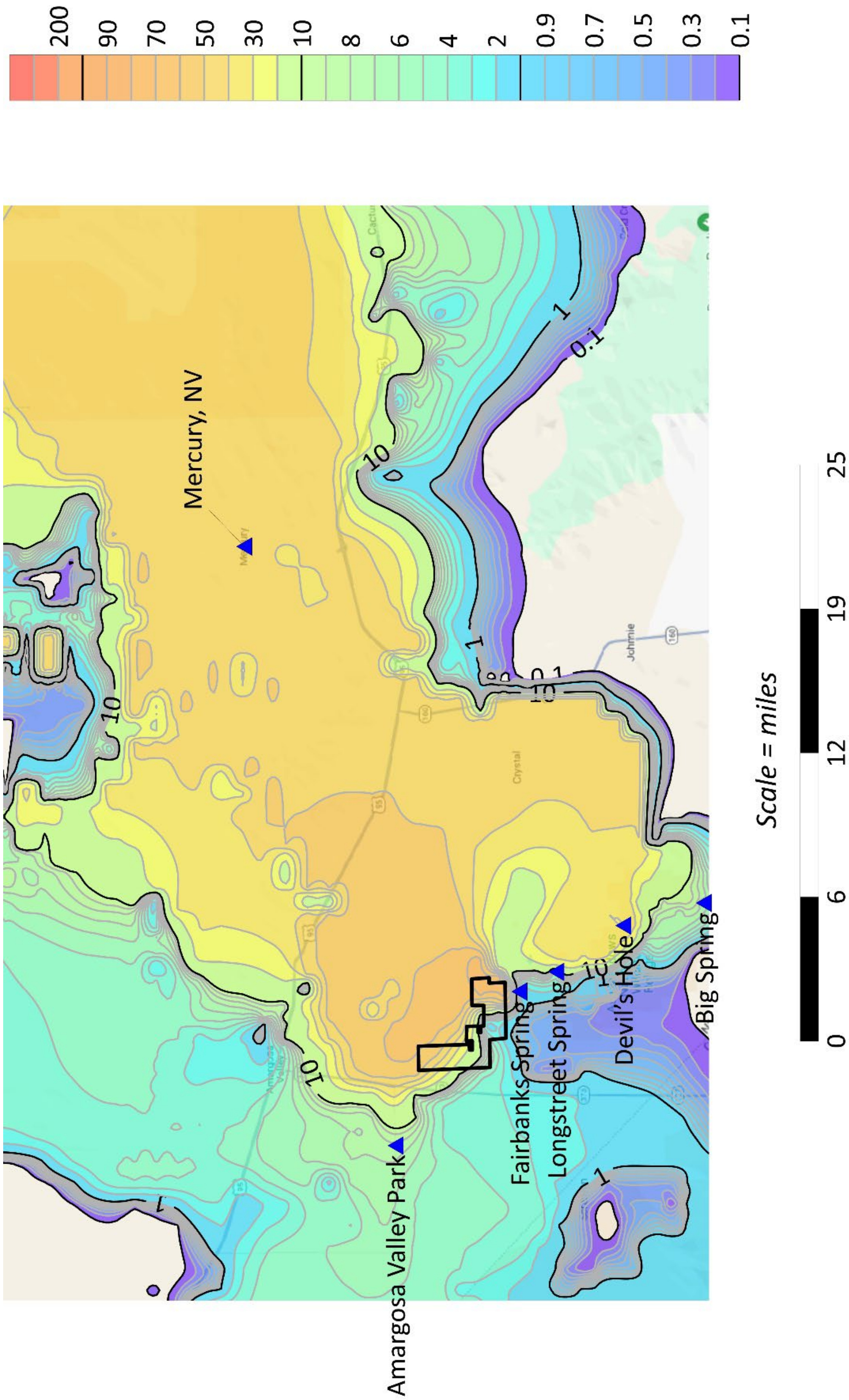
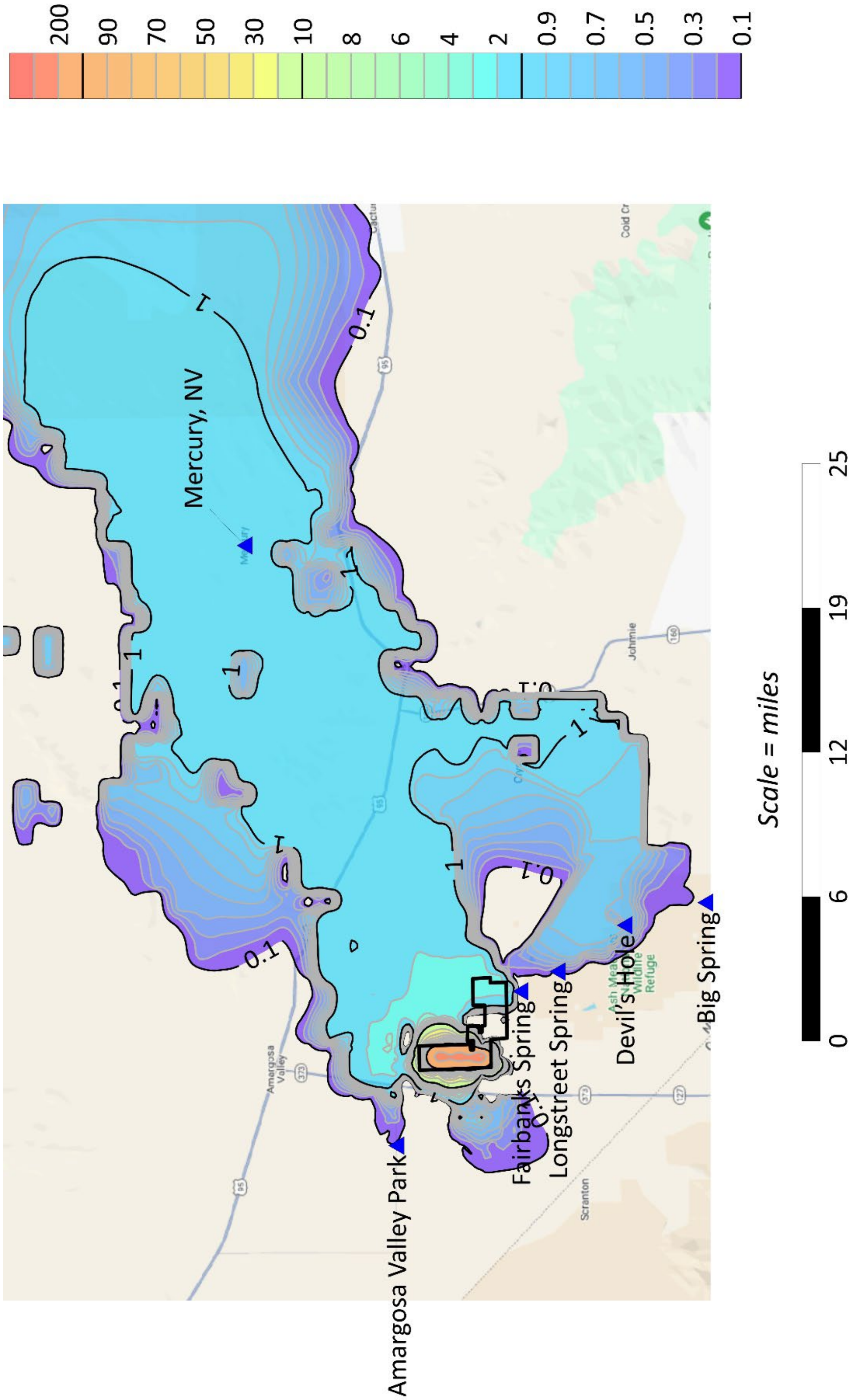
ATTACHMENT A – 9,000 GPM (combined) for 10 years (incomplete dewatering) from wells east of Gravity Fault – West Claim Block



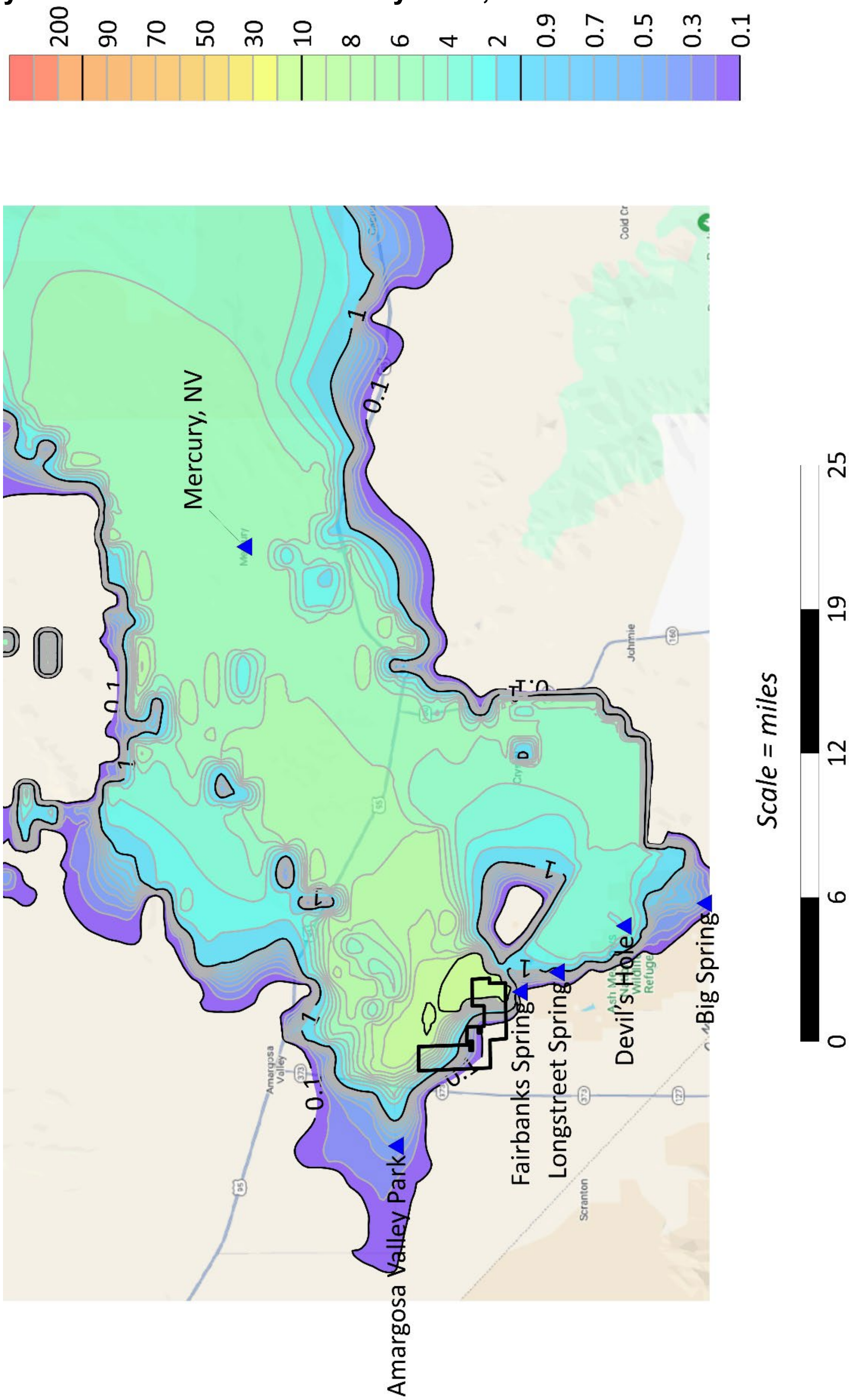
ATTACHMENT B – 9,000 GPM (combined) for 100 years (incomplete dewatering) from wells east of Gravity Fault – West Claim Block



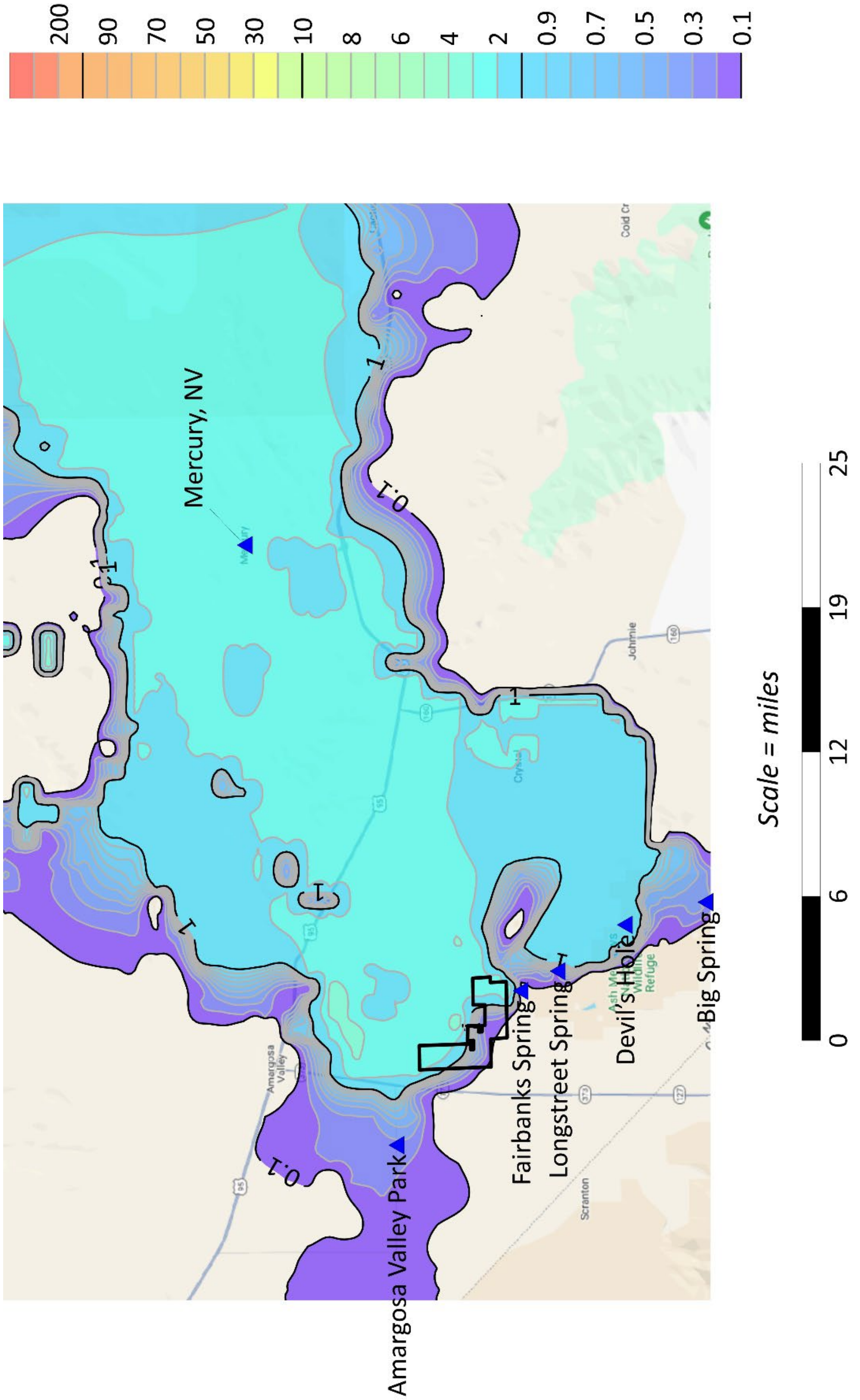
ATTACHMENT C – 2,000 GPM (combined) for 10 years with full dewatering from wells west of Gravity Fault – West Claim Block

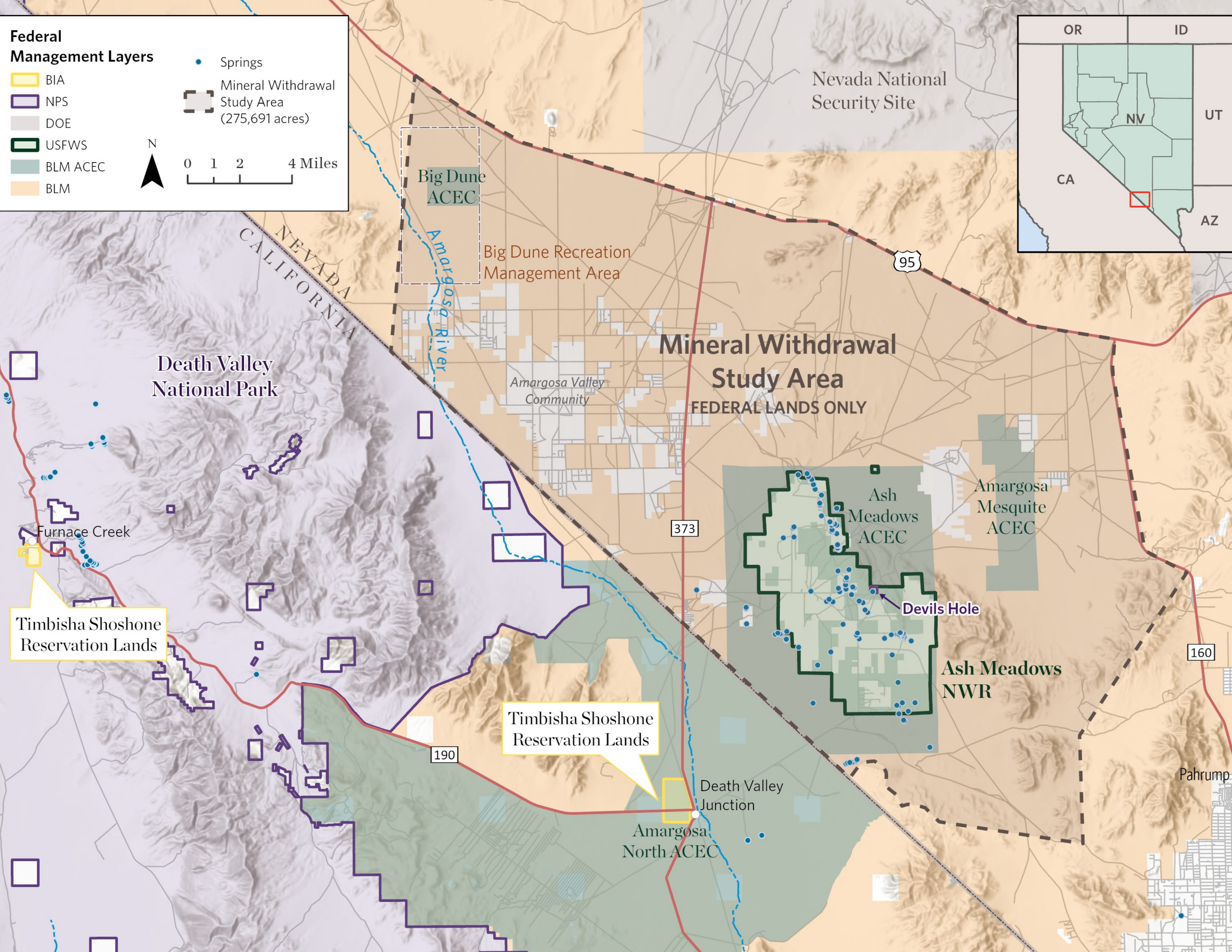


ATTACHMENT D – Reduced pumping to achieve 10 feet of dewatering for 10 years from east side of Gravity Fault, West Claim Block



ATTACHMENT E – Residual Drawdown 10 years after cessation of reduced pumping to achieve 10 feet of dewatering for 10 years from east side of Gravity Fault, West Claim Block





Federal Management Layers
BIA
NPS
DOE
USFWS
BLM ACEC
BLM
Springs
Mineral Withdrawal Study Area (275,691 acres)
N
0 1 2 4 Miles
OR
ID
NV
UT
CA
AZ
Nevada National Security Site
Big Dune ACEC
Big Dune Recreation Management Area
Amargosa River
NEVADA
CALIFORNIA
95
Mineral Withdrawal Study Area
FEDERAL LANDS ONLY
Death Valley National Park
Amargosa Valley Community
373
Ash Meadows ACEC
Amargosa Mesquite ACEC
Furnace Creek
Devils Hole
Timbisha Shoshone Reservation Lands
Ash Meadows NWR
160
Timbisha Shoshone Reservation Lands
190
Death Valley Junction
Pahrump
Amargosa North ACEC

MEMORANDUM

Date: June 5, 2024

To: Jaina Moan – The Nature Conservancy

From: Andy Zdon, P.G., C.E.G., C.Hg, Josh Osborne, P.G., Dylan Bailey, Staff Geologist II

Subject: **Technical Memorandum – Minerals Review for Proposed Mineral Withdrawal Study Area, Nye County, Nevada**

Roux Associates, Inc. (Roux) is pleased to provide The Nature Conservancy (TNC) with this Technical Memorandum (memo) summarizing our minerals review related to the proposed mineral withdrawal in the Ash Meadows National Wildlife Refuge (NWR) area of Nye County, Nevada. The proposed minerals withdrawal is part of an initiative to provide hydrogeologic protections to the springs at Ash Meadows NWR and similarly the Devil's Hole unit of Death Valley National Park (Figure 1 on the following page). Additionally, the proposed minerals withdrawal will be protective of the general groundwater resources of the Amargosa Desert hydrographic basin (Nevada 14-230). This region is hydrologically upgradient of the Shoshone-Tecopa portion of the Amargosa River in California, and the proposed minerals withdrawal will also be protective of the Amargosa Wild & Scenic River.

Roux evaluated existing minerals exploration records and related information for identifying potential mineral commodities (inclusive of oil and gas and geothermal potential) that would be withdrawn resulting from the proposed mineral withdrawal. Based on our review Roux identified the following:

- clay commodities;
- lithium;
- crushed stone and sand and gravel; and,
- metallics (primarily limited to upland bedrock areas).

With two unsuccessful oil and gas exploratory boreholes, and the apparent lack of geothermal resources in the area, Roux believes that no significant oil, gas, or geothermal resources would be withdrawn due to the proposed minerals withdrawal.

There are more than 3,000 active mining claims within the proposed minerals withdrawal area, and different databases vary in the information provided. Despite these inconsistencies, Roux believes that the information provided in this memo provides a comprehensive overview of the mineral commodities of interest within the proposed minerals withdrawal area. A large claim block consisting of hundreds of claims (number unspecified) was located during 2024, extending from the area of Longstreet northward toward Amargosa Valley. These claims were recently posted by Rover Critical Minerals, Inc. (Rover) but at the present time have yet to be registered. Roux could not identify information related to these claims on any of the associated online databases.

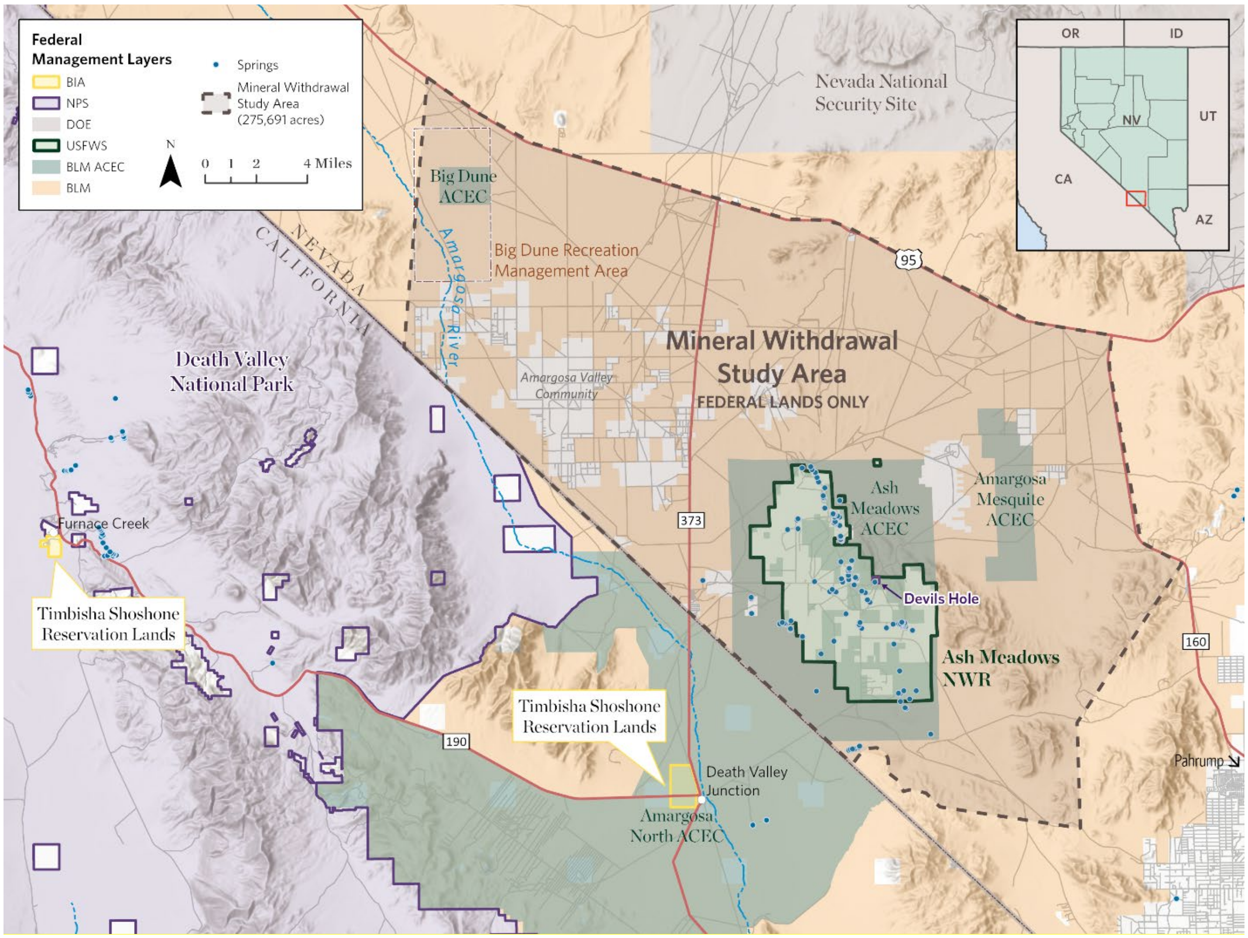
Background

Ash Meadows NWR and the Devil's Hole Unit of Death Valley National Park are within the Amargosa Desert hydrographic basin 14-230 in Nye County, Nevada. The Ash Meadows NWR is identified as a groundwater discharge location within the Death Valley Regional Flow System, with numerous large springs and sensitive habitat for desert pupfish and numerous other Endangered Species Act (ESA) listed wildlife and plant species. Flow from the large springs in the Refuge is largely derived from the carbonate rock aquifer of the Death Valley Regional Flow System. Discharge from the carbonate rock aquifer at Ash

3763.0001S100

Meadows occurs both directly, via spring discharges, and indirectly, via the shallow basin-fill aquifer, which in turn contributes to spring discharges. In other words, the shallow and deep aquifers in this region are hydrologically connected and both contribute flow to surface springs in the Ash Meadows NWR. Groundwater extraction from potential mineral exploration or active mining (inclusive of potential dewatering) could impact these springs at Ash Meadows and at Devil's Hole. This has led to the proposed minerals withdrawal area shown on Figure 1. This area is generally upgradient of, and in an area hydraulically connected to, Ash Meadows NWR and Devil's Hole.

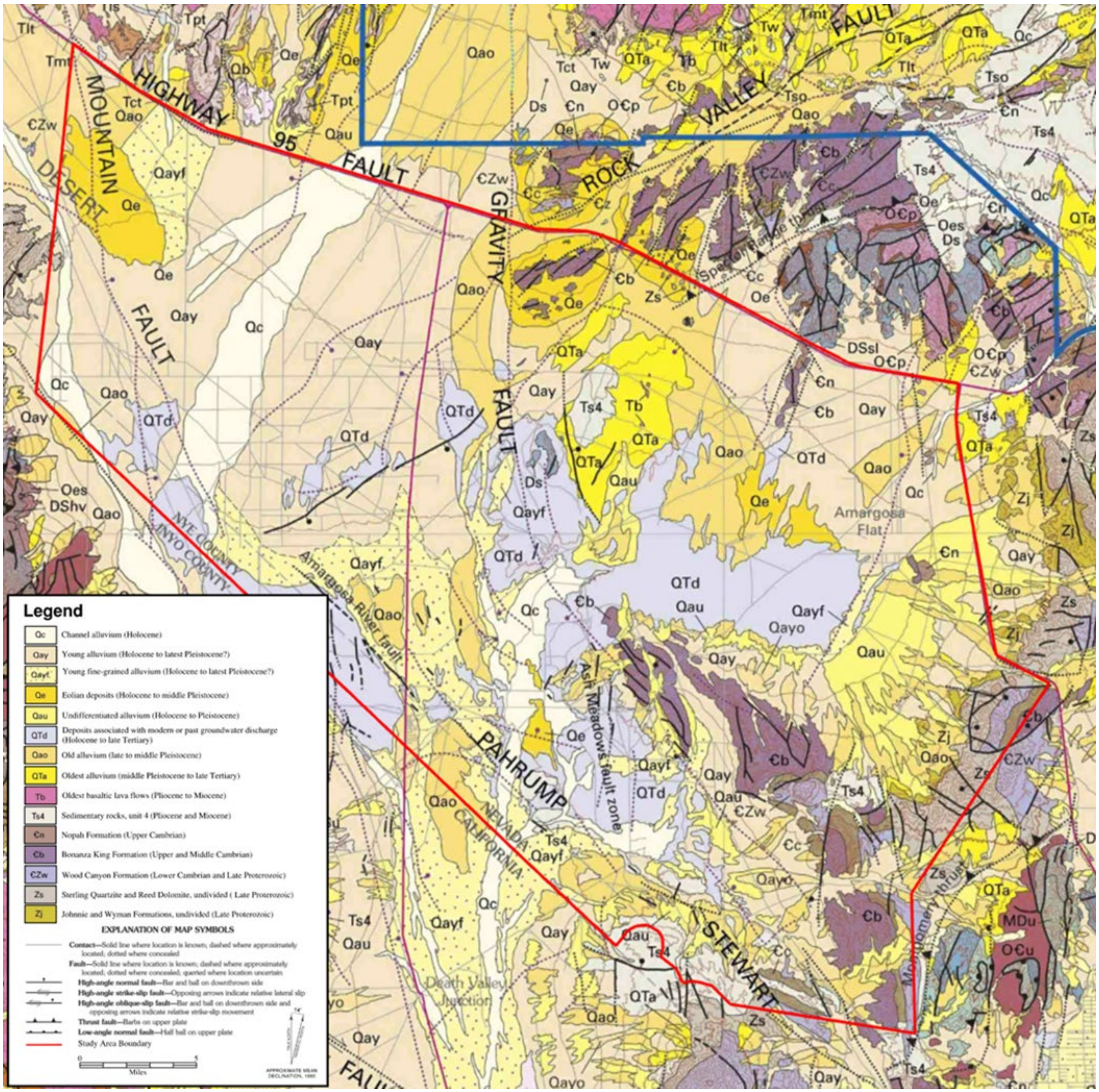
Figure 1 – Location of Ash Meadows NWR and proposed minerals withdrawal area.



Geologic and Hydrogeologic Characteristics of the Ash Meadows Area

The study area is within the Basin and Range Geomorphic Provence, which is characterized by north-northwest trending mountain ranges and basins with considerable topographic relief and internal drainage. The proposed minerals withdrawal area encompasses a majority of the southern Amargosa Valley and is bounded to the south by the Last Chance Range (Nevada), Resting Springs Range, and Stewart Valley; to the west by the Nevada-California border, Crater Flat and northern Amargosa Valley; and to the north and the east by the Specter Range. A geologic map of the study area is presented in Figure 2 on the following page. In Figure 2, the proposed minerals withdrawal area is provided in the polygon outlined in red. The blue line in the northeast corner of the map is the boundary of the Nevada National Security Site. The Nevada National Security Site (NNSS) is part of the U.S. Department of Energy's National Nuclear Security Administration special-purpose, high-hazard experimentation facilities providing service solutions in partnership with the National Laboratories (National Nuclear Security Administration, 2024).

Figure 2. Mineral Withdrawal Study Area Geologic Map (adapted from Workman et.al., 2002).



The principal basin fill deposits that are present within the mineral withdrawal study area (Workman et.al., 2002) include the following:

- Quaternary Channel alluvium (Holocene) - Unconsolidated gravel, sand, and silt; generally associated with zones of active to very recent surface water flow and deposition. May contain varying proportions of secondary carbonate, gypsum, and salts. Surficial deposits with thicknesses generally varying from zero to 30 feet. Typically underlain by older basin fill deposits;

- Quaternary younger alluvium (Holocene) - Mostly unconsolidated or poorly consolidated, medium-to-coarse grained alluvium consisting of boulder, pebble, gravel, and sand, but which may locally include fine-grained deposits of sand and silt. Ranges in thickness up to 100 feet;
- Quaternary undifferentiated alluvial deposits (Holocene to Pleistocene) – areas where basin fill consists of mixture of differing alluvial materials;
- Quaternary to Tertiary Groundwater Discharge Deposits (Holocene to late Tertiary) - Associated with modern or past groundwater discharge (spring deposits). Generally fine-grained deposits of fine sand, silt, and mud, but may locally include dense crystalline deposits of limestone or travertine. Variably indurated, from unconsolidated to cemented. Generally up to 30 feet thick although can be locally thicker;
- Quaternary Older Alluvium (mid-to-late Pleistocene) – Generally medium-to-coarse grained gravel and sand but may locally include regions with fine-grained sand and silt. Variably indurated. Thickness may exceed 1,500 feet at some locations;
- Quaternary-Tertiary Oldest Alluvium (mid-Pleistocene to late Tertiary) - Medium to coarse-grained gravel (boulder to pebble) and sand. Variably indurated, ranging from poorly consolidated beneath cemented surface soils to well cemented throughout. Generally up to 300 feet thick but may increase to more than 1,000 feet locally.

Bedrock units present within the minerals withdrawal boundary typically consist of the Paleozoic and late Proterozoic metasedimentary rocks including:

- Middle-Devonian Simonson Dolomite;
- Upper Cambrian Nopah Formation (dolomite and shale);
- Upper and Middle Cambrian Bonanza King Formation (limestone and dolomite);
- Middle and Lower Cambrian Carrera Formation (interbedded limestone, siltstone, sandstone, and shale);
- Lower Cambrian Zabriskie Quartzite (massive quartzite);
- Lower Cambrian to late Proterozoic Wood Canyon Formation (quartzite, sandstone, siltstone, shale, and dolomite);
- Late Proterozoic Stirling Quartzite (quartzite and sandstone) and Reed Dolomite (medium to coarsely crystalline dolomite, with minor amounts of limestone, siltstone, and quartzite); and,
- Late Proterozoic Johnnie and Wyman Formations consisting of quartzite, conglomeratic quartzite, siltstone, shale, with minor amounts of limestone and dolomite.

Miocene rhyolitic flows can be found to the south of the Ash Meadows NWR and may be part of the Nevada volcanic field (Castor et.al., 2006).

The Amargosa Desert (in which Ash Meadows is located) is underlain by a deep, steep-sided trough extending from the southwest Nevada volcanic complex to the Nevada -California state line. The linear margins of the Amargosa Desert trough and its internal topography suggest that it formed as a series of transtensional basins that transferred strain between right-stepping, northwest-striking, right-lateral, strike-slip faults (Blakely, 2007). Within that setting, the Gravity Fault (normally considered a high-angle normal fault as shown on Figure 2) serves as a key structural feature in the Ash Meadows as described further below in the hydrogeologic discussion. The Gravity Fault, which causes a change in groundwater levels and has a key role in the surfacing of spring flow in the Ash Meadows area, was originally identified in the 1970’s through geophysical investigations. Blakely and others (2007) estimated approximately two kilometers of vertical offset on the Gravity fault. However, The juxtaposition of the Gravity Fault on other faulting, including that of the Furnace Creek Fault Zone, the Pahrump-Stewart Valley Fault Zone, and the remaining portions of the Ash Meadows Fault Zone south of the Gravity Fault (as presented by Workman et.al., 2002), also suggests the presence of a complex structural regime, which may also be influencing groundwater levels.

The following description of the hydrogeologic characteristics of the Ash Meadows NWR and Devil's Hole area is largely paraphrased from Laczniak et.al. (1999). It is presented here as it puts into context the nature of the groundwater-dependent ecosystem that is intended to receive the protections of the proposed minerals withdrawal. The groundwater-dependent ecosystem at Ash Meadows NWR and Devil's Hole is a result of the area's unique hydrogeology. The many springs and shallow water table in the area are maintained primarily by groundwater that moves into the area from the north and northeast through a thick, semi-continuous carbonate-rock aquifer system (largely Bonanza King limestone). Groundwater moving through this aquifer originates from precipitation falling on the higher mountain ranges and mesas throughout an area that extends hundreds of miles to the north and east. Along the flowpath from source to discharge point, carbonate-rock units carrying most of the groundwater are buried by thick accumulations of sediments that make up the basin fill.

At Ash Meadows, the groundwater flow is impeded by a generally northwest to north trending fault zone termed the Fault (Laczniak, 1999). As noted earlier, the Gravity Fault causes an abrupt change in hydraulic characteristics with higher transmissivity, faulted and fractured carbonate-rock to the east; and the less transmissive fine-grained lakebed sediments and generally coarser alluvial basin-fill sediments to the west (Figure 2). This change in hydraulic characteristics forces groundwater flow to the surface in the form of the Ash Meadows springs and Devil's Hole.

Devil's Hole is within an isolated unit of Death Valley National Park adjacent to Ash Meadows NWR and to the east. Unlike the springs in Ash Meadows that discharge large volumes of groundwater (more than 10,000 gpm combined), water at Devil's Hole is present in a carbonate-rock grotto.

Mining Districts Within the Proposed Mineral Withdrawal Study Area

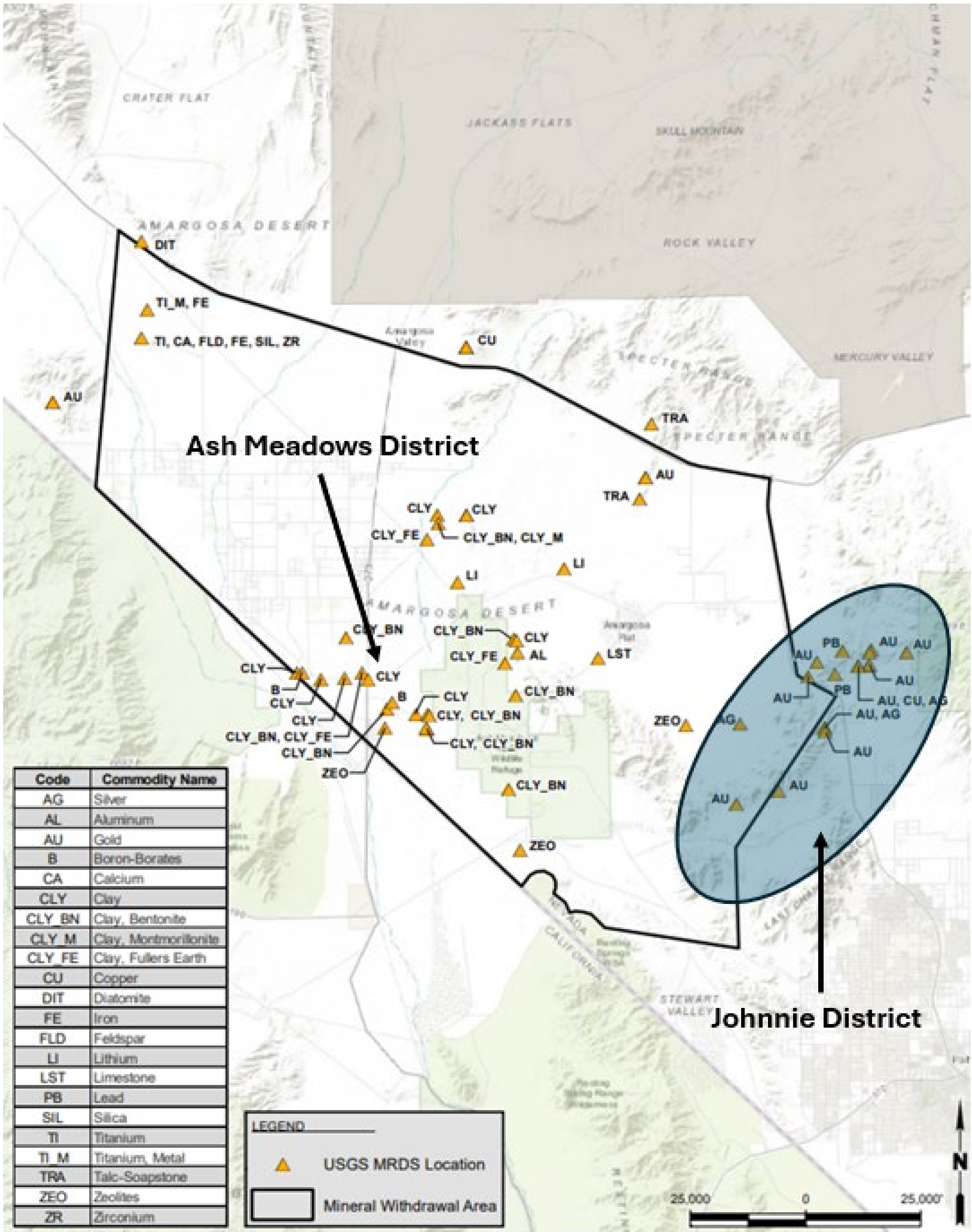
The Ash Meadows Mining District is approximately one mile east of Nevada Highway 373, and immediately north of the Nevada-California state line. According to the online minerals database on Mindat.org (2024), the sole commodities that have been produced from the Ash Meadows Mining District include the zeolite mineral Clinoptilolite, bentonite and other clay products. The district has been noted in the literature as early as 1917 (Kral, 1951). Currently, the principal mining operation in the Ash Meadows Mining District is the Amargosa Clay Operation operated by Lhoist North America, Inc.

The southwestern portion of the Johnnie Mining District lies within the eastern boundary of the proposed minerals withdrawal at Mount Montgomery. Discovered in 1905, the principal mineral commodities associated with district include gold, silver, and lead. Although there has been substantial exploration in the Johnnie District, there have been no discoveries leading to active or planned mines using modern mining methods.

Known Mineral Resources of the Proposed Mineral Withdrawal Study Area

Mineral resources of the southern Amargosa Valley have been mined since at least the early 1900s. Commodities of significance include clay to the north, east, and west of the Ash Meadows NWR, zeolite deposits to the south of Ash Meadows NWR; metallic minerals including silver, aluminum, gold, copper, iron, lead, and titanium primarily found in the outcropping bedrock units. The following subsections summarize each of these commodities in detail. An overview map of active mining claims within the proposed mineral withdrawal zone is provided in Figure 3. Although boron is a well-known commodity in the Death Valley region, it appears less of a mineral fo interest in this area based on the results of the mining claim review (USGS, 2024, Figure 3)

Figure 3. Mining Claims and Associated Minerals, Proposed Mineral Withdrawal Study Area



Clay Commodities

Clay mining began in the Amargosa Valley in the 1910s and temporarily ceased in the 1950s following the extraction of more than 180,000 short tons of clay from the Clay Camp area (Kral, 1951, Castor, et.al., 2006). In the 1970s, clay mining resumed when Industrial Minerals Ventures (IMV) began mining to the northeast of Ash Meadows NWR. As of 2022, the Amargosa Clay Operation (now operated by Lhoist North America) was listed as the only clay mining operation in the southern Amargosa Valley (Nevada Bureau of Mines and Geology, 2023, BLM, 2024) with an annual total of 38,500 short tons of clay mined. The USGS has ranked the mineral potential for clay in the southern Amargosa Valley as high, with principal clay commodities being montmorillonite, saponite, and sepiolite. The clay occurs in shallow, flat-lying deposits within Pliocene-age lacustrine rocks (Castor, 2003).

Montmorillonite

Montmorillonite consists of sodium and/or calcium smectite and is part of the smectite clay-mineral group. Sodium-rich montmorillonite is used in drilling fluid as well as in cat litter among other products requiring a high-swelling capacity. Calcium-rich montmorillonite has less swelling capacity than the sodium-rich form and is often used as a foundry bonding clay. Deposits of montmorillonite are found in the late Pliocene and Pleistocene lakebed deposits around the periphery of the Ash Meadows NWR and slightly above the valley floor (Kral, 1951). Mine pits continue to produce Montmorillonite as a high-quality commodity from the Amargosa Clay Operation.

Saponite

Saponite is similar to montmorillonite but is distinguished by its chemical and structural differences (being magnesium rich). Saponite is mined from pits northeast and northwest of the Ash Meadows NWR (Castor, et.al., 2006). The saponite deposits are widespread clay-rich beds within the Quaternary playa deposits of Amargosa Valley. Due to the presence of iron compounds, the saponite is commonly light brown to light green (Wahl and Papke, 2003). Due to saponite's low shrinkage properties, it is an ideal additive to stucco as it does not shrink when it dries (Miles, 2011). Saponite is used in other construction materials and environmental sealants and liners.

Sepiolite

Sepiolite is a fibrous clay often used as a drilling fluid additive in salt-water and geothermal drilling muds as well as for absorbent products like cat litter. Sepiolite is a rare commodity and the Amargosa sepiolite deposits are the only known commercially viable deposits in the United States (Castor, et.al., 2006). The Amargosa sepiolite deposit is found in the Amargosa Flat, an approximately 2.5-mile-wide strip to the east of the Ash Meadows NWR. The sepiolite deposits consist of an almost continuous bed as much as 20 feet thick but typically about six feet in thickness (Wahl and Papke, 2003).

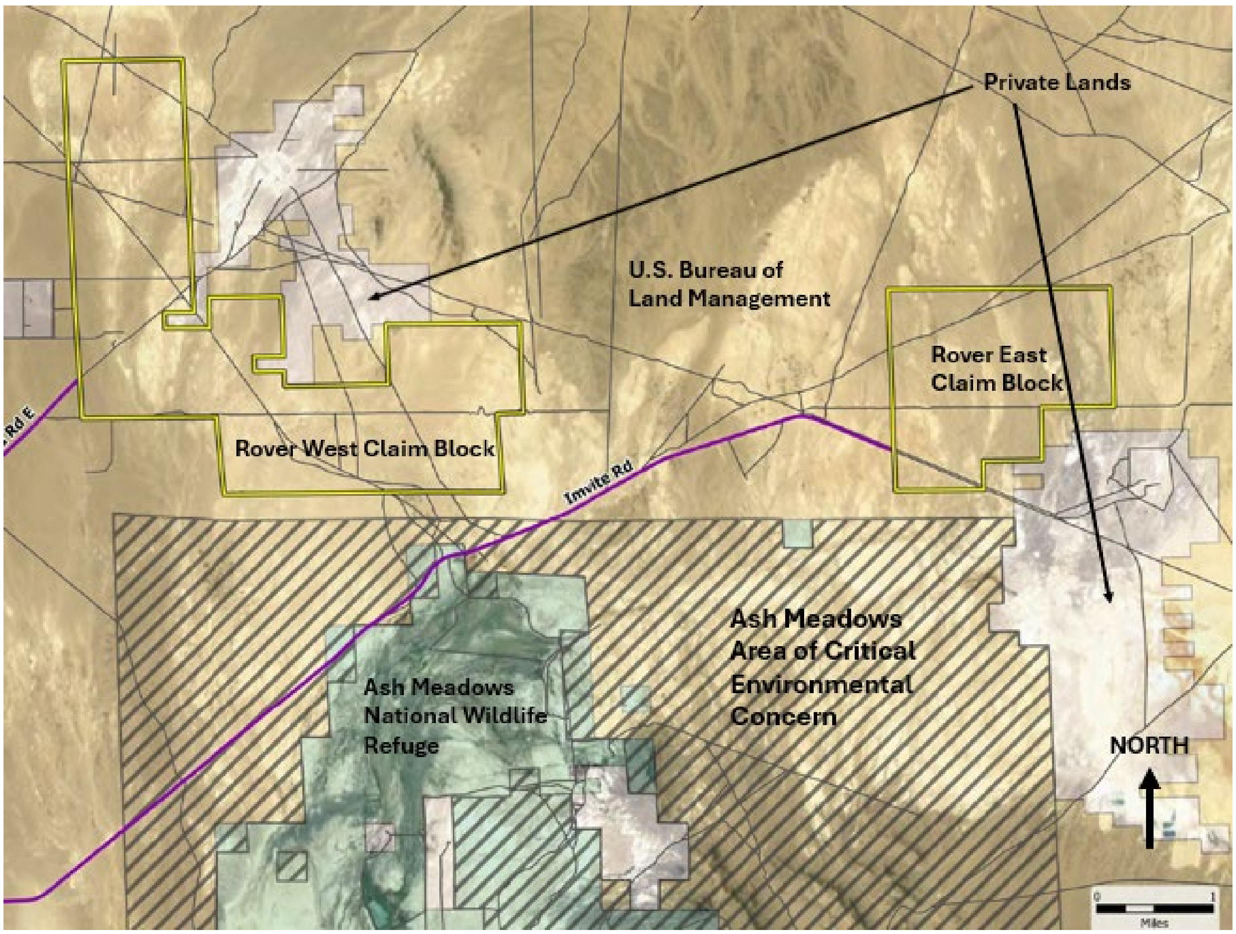
<u>Zeolites</u>

Deposits of the zeolite mineral clinoptilolite have been mapped in the southwestern part of the Ash Meadows NWR extending southwest towards, and crossing, the California border (Castor et.al., 2006). The principal area of mining has occurred on the California side of the Ash Meadows area (Castor, 2003). The zeolite deposits occur within Miocene or Pliocene sandstone and claystone and come in a variety of colors including white, pale-yellow, and green. The clinoptilolite deposit is understood to have been associated with a 46 to 122-meter thick ash-flow tuff dipping 15-30 degrees to the east (Castor et.al., 2006). Zeolite minerals are used in laundry detergents, oil refining and petrochemical industries, adsorbents, gas separations, agriculture and horticulture, pigments, and jewelry (Maesen, 2007). The USGS has ranked the mineral potential for zeolite to the south of the Ash Meadows NWR as being high.

Lithium

Lithium claims are present adjacent to the northern boundary of the Ash Meadows NWR – Devil's Hole area. Rover Critical Minerals Inc. (Rover) has proposed to conduct mineral exploration drilling for lithium in the area north of, and immediately adjacent to the Refuge (Zimmerman, 2022). The claims comprise two blocks (a West Claim Block and an East Claim Block). A geologic report was prepared by John Zimmerman of GenGold2, LLC for Rover's "Let's Go Lithium" Project (Zimmerman, 2022). According to that report, the lithium is to be found within Quaternary- to Tertiary-aged lacustrine deposits. Hand-collected surface samples are reported to contain up to 910 parts per million of lithium (Rover Critical Minerals, 2024). A map illustrating the proximity of the Rover project relative to Ash Meadows NWR is provided in Figure 4.

Figure 4. Rover claim blocks and adjacent land status (adapted from UES, 2023).



The Battery Mineral Resources claims northeast of the Rover claims, are also in the exploration phase although there is no record of exploration drilling as having taken place at that location as of this date. Unlike the Rover lithium claims, which are in claystone, the Battery Mineral Resources claims are for lithium in brines (Battery Mineral Resources, 2024).

Crushed Stone and Sand and Gravel

The eastern Ash Meadows NWR is underlain by carbonate rocks, suggesting the potential for crushed stone resources in the area. The Nopah Formation mapped in this area has a low chert content, lending to the high potential for crushed stone aggregate. Younger sediments mapped in the southern Amargosa Valley are friable and are not considered a potential source of crushed stone (Castor, et.al., 2006). Crushed stone aggregate potential within the southern Amargosa Valley is considered low to high with low to moderate certainty.

Fine grained sediments of the southern Amargosa Valley are considered to have a low potential for sand and gravel aggregate production. However, sand and gravel deposits in the vicinity of Devils Hole have a high potential for production where carbonate outcrops occur (Castor, et.al., 2006).

Metallic Minerals

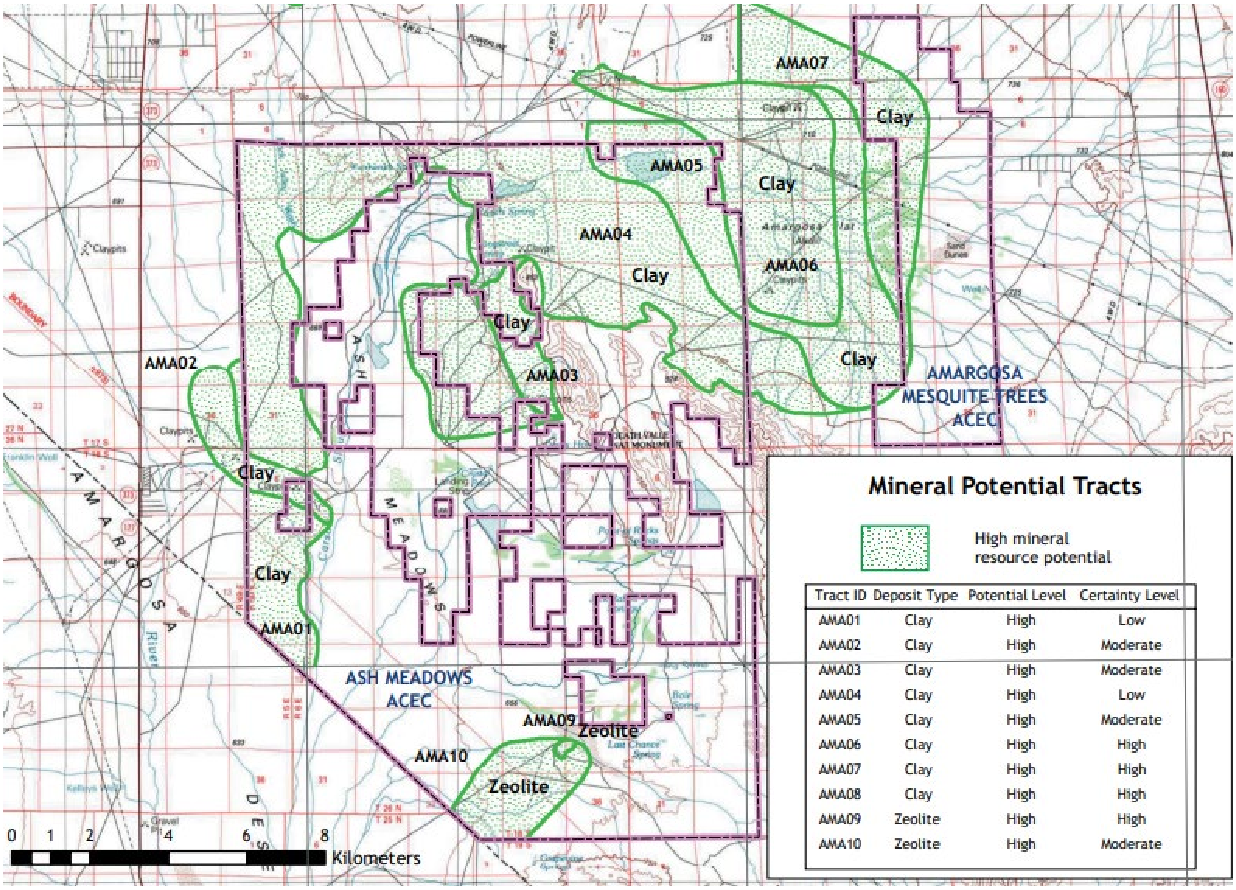
Although there is no indication of the presence of metallic minerals within the Ash Meadows NWR, metallic minerals including silver, aluminum, gold, copper, iron, lead, and titanium are known minerals within, or immediately adjacent to, the proposed minerals withdrawal area (U.S. Bureau of Land Management, 2024), as shown on Figure 3. Metallic mineral occurrence is most typically observed at elevations above the sediments of the valley floor (e.g., in the Johnnie Mining District). Although substantial exploration has occurred in the Johnnie Mining District, there are no discoveries or planned mining operations consistent with modern mining methods in the district However, claims for iron, titanium, and silver have been identified in the flats of the southern Amargosa Valley (U.S. Bureau of Land Management, 2024).

Claims Near the Ash Meadows National Wildlife Refuge

Clay and zeolite mines operate within the immediate vicinity of the Ash Meadows NWR (Figure 3 [minerals map]). The Amargosa Clay Operation mines (operated by Lhoist North America) clay products to the north, east, and west of the Ash Meadows NWR removing an estimated 30,000 tons of clay each year. The KMI Zeolite, Inc. operates on private land within the outer footprint of the Ash Meadows NWR boundary, although this appears to be for processing only. The USGS lists a second zeolite mine south of the Ash Meadows NWR across the Nevada-California border known as the Zeolites International Mine. This appears to be operated by St. Cloud Mining (Saint Cloud Mining, 2024).

No metallic mines are known to operate within the immediate vicinity of the Ash Meadows NWR. All identified metallic mining operations were observed at higher elevations of the Johnnie District at Mount Montgomery, or far north of the boundary of the Ash Meadows NWR. These are remnants of historic, small-scale mining operations, atypical of current, larger-scale mining operations (e.g., open-pit operations). A focused map of the Ash Meadows NWR-Devil’s Hole area showing areas of potential mineral resources in that specific area is presented in Figure 5 on the following page.

Figure 5. Ash Meadows NWR-Devil's Hole focused area mineral potential (adapted from Casto et.al., 2006).

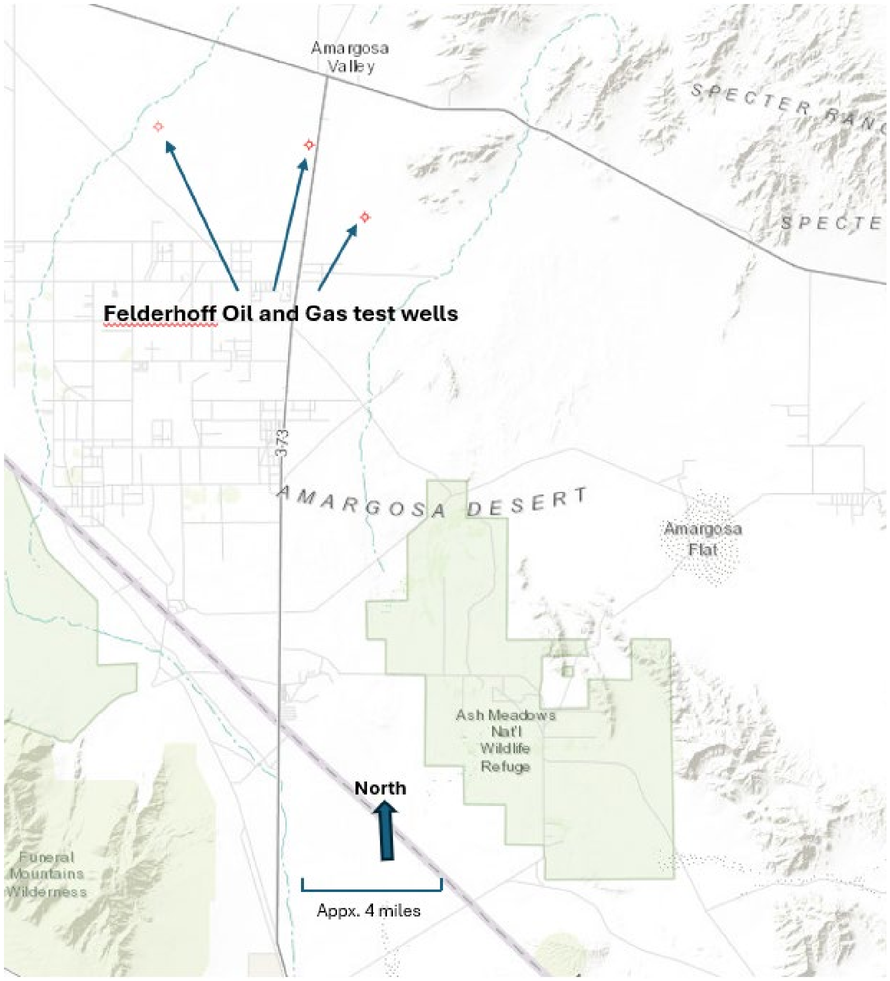


Oil and Gas Exploration and Production

The BLM identifies the Amargosa Valley as a region moderately favorable for oil and gas (Castor et.al., 2006). Exploration for oil and gas resources has been conducted within the southern Amargosa Valley. Records from the U.S. Bureau of Land Management's MLRS (U.S. Bureau of Land Management, 2024) indicate that oil and gas exploration in the SAV occurred in the 1990s.

Records available through the MLRS website and the Nevada Bureau of Mines and Geology Oil and Gas Well Finder site (Nevada Bureau of Mines and Geology, 2024) indicate that three exploratory wells have been permitted within the proposed minerals withdrawal boundary, The exploratory wells were advanced by the Felderhoff Production Company and were named Felderhoff – Federal Nos. 5-1, 25-1, and 29-1, respectively. Felderhoff – Federal No. 5-1 was completed to a depth of 1,466 feet below ground surface. No lithologic data are available for this well and there is no indication of any discovery in this exploratory hole. Felderhoff – Federal No. 25-1 was completed to a depth of 5,003 feet below ground surface with alluvium encountered from ground surface to 343 feet below ground surface, basalt from 343 to 518 feet below ground surface, Tertiary-aged gravels from 518 to 2,000 feet below ground surface, and Cambrian-aged dolomite from 2000 feet below ground surface to total depth. No oil and gas discovery was indicated. Felderhoff – Federal No. 29-1 was never drilled (Nevada Bureau of Mines and Geology, 2024a). The two exploratory wells that were drilled were abandoned. The records of these exploratory wells are provided in Attachment A. The location of the Felderhoff test wells are provided on Figure 6.

Figure 6. Location of Felderhoff test oil and gas wells.



There are no records of oil and gas production from within the proposed minerals withdrawal study area.

Geothermal Exploration and Production

There are no geothermal power plants within the proposed minerals withdrawal study area. Additionally, although there are more than 1,000 wells noted within the boundary of the proposed minerals withdrawal, none of the wells had waters exceeding 37 degrees centigrade (98.6 degrees Fahrenheit)(Nevada Bureau of Mines and Geology, 2024b). Low temperature geothermal resources are generally those below 150 degrees centigrade and are generally used for individual homes and businesses (U.S. Department of Energy, 2024). Lower temperature geothermal energy development (e.g., binary cycle geothermal plants) operate with fluid temperatures of at least 100 degrees centigrade (Fazal and Kamran, 2021) . Given the low temperatures identified in well waters within the boundary area and lack of historic geothermal production, future geothermal production is highly unlikely in this area.

Conclusions

The principal mineral occurrences identified to be in, or potentially in, the proposed minerals withdrawal boundary were 1) clay commodities; 2) lithium; 3) crushed stone and sand and gravel; and 4) metallics (primarily limited to upland bedrock areas). Three unsuccessful oil and gas test holes were identified within the proposed minerals withdrawal boundary. There were no indications of geothermal resources within the proposed minerals withdrawal boundary.

A large claim block consisting of hundreds of claims (number unspecified) was located during 2024, extending from the area of Longstreet and extending northward toward Amargosa Valley. These claims were posted by Rover Critical Minerals, Inc. (Rover) but at the present time, Roux could not identify information related to these claims on any of the associated online databases. Due to the recent status of the claims, information about associated minerals of interest is not available although Rover's other claims in the area are for lithium.

There were no mineral deposits identified on the U.S. Geological Survey's USMIN mineral deposit database (U.S. Geological Survey, 2024a). Data identified on the MRLS database (U.S. Geological Survey, 2024b) were consistent with those on the U.S. Bureau of Land Management's MLRS database (2024) although the data on the MLRS appeared to be more current.

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MEMORANDUM

ROUX

Date: June 23, 2023

From: Andy Zdon, P.G., CEG, C.Hg.

Subject: **Proposed Ash Meadows Lithium Exploration**

Rover Metals (USA) Inc. (Rover) has proposed to conduct minerals exploration drilling in the area north of, and immediately adjacent to, Ash Meadows National Wildlife Refuge in Nevada. The proposed drilling scope includes 23 boreholes of depths of up to 300 feet within the Amargosa Desert Hydrographic Basin (14-230) in the Death Valley Regional Flow System. The Ash Meadows National Wildlife Refuge (Refuge) is noted as a groundwater discharge location with numerous large springs and sensitive habitat for desert pupfish and numerous other listed wildlife and plant species. Roux Associates (Roux) has reviewed pertinent information relating to the proposed drilling project and have prepared the following comments regarding the proposed project and springs in the Refuge.

A geologic report was prepared by John Zimmerman of GenGold2, LLC for the “Let’s Go Lithium” Project (Zimmerman, 2022). This report provides a brief summary of conditions in the proposed drilling area, but gives little information related to the groundwater hydrology of the proposed project area relative to the Refuge. Of note is that drilling is proposed less than 2,000 feet from Fairbanks Spring in Ash Meadows.

APPROACH

In order to consider the risks associated with the proposed mineral exploration drilling including impacts to springs at the Refuge, Roux reviewed logs for existing wells within the footprint of the proposed drilling project area, particularly in the area of the boundary of the Refuge and the proposed project footprint as illustrated in the Zimmerman report (State of Nevada Division of Water Resources, 2023). Additionally, we relied on information developed over the author’s years of preparing a series of Amargosa Basin State of the Basin Reports covering the Amargosa Basin in both Nevada and California. One key well log, that of log 98656 for a dual completion monitoring well installed by the U.S. Geological Survey on behalf of the U.S. National Park Service is critical to the review as the well feature is within the immediate area of proposed drilling north of Fairbanks Spring. Other references relied on by Roux included information forwarded to us by Mason Voehl of Amargosa Conservancy that include correspondences inclusive of a Voluntary – 43 CFR 3809 Exploration Notice Form prepared by Rover Metals, and associated information.

This review describes, and is focused on, potential critical impacts that may occur, and that would likely occur first. Given the sensitive receptors (springs) present adjacent to the proposed drilling project, potential environmental effects caused by the pumping would appear first at springs such as Fairbanks and/or Longstreet in the Refuge. Corrective action occurring as a result of identification of spring impacts at these locations, would then be protective of other more distant sensitive receptors that may be effected.

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WELL LOG 98656

This dual completion well was installed by the U.S. Geological Survey to a total depth of 510 feet below ground surface (ft bgs). The well log is provided as Attachment A. The dual completion well is within the footprint of proposed exploratory boreholes immediately north of Fairbanks Spring.

The dual completion well comprises a shallow well with screen and filter pack zone extending from 305 to 345 ft bgs, and a deep well with screen and filter pack zone extending from 446 to 510 feet was constructed and the wells developed (airlifting). Airlifting is the process of injecting compressed air down the borehole, forcing water to the surface and could be used to clean the borehole of drilling fluid and other sediment caked to the borehole wall prior to installing well casing and other materials. Cleaning the hole will also result in water being able to enter the borehole more easily. Airlifting can also be used as a preliminary method of estimating what the eventual yield of a well may be (for more information on a common use of airlifting during well construction see the article at https://waterwelljournal.com/well-development-using-compressed-air). Basin-fill materials encountered during drilling included alternating layers of clays and coarse-grained materials with the shallow well appearing to be constructed within gravelly zones interbedded with clays, while the deep well appears to have been constructed in bedrock, possibly quartzite.

Of note is that after airlifting, both the shallow and deep wells exhibited artesian conditions, with free flow of approximately 1 gallon per minute at the ground surface from the shallow well, and approximately 36 gallons per minute from the deep well. The log does not identify the depth at which groundwater was first encountered, nor do the logging intervals presented provide specific detail regarding the stratigraphy of the borehole. Depths of soils and rock encountered are described in even 10's or 100-foot intervals. Therefore, the depths of water-bearing zones could vary significantly within the hole. The presence of artesian conditions in this area is not surprising given the presence of the spring field in the Refuge, Devil's Hole, and an artesian well in the basin-fill known as the "Hog Farm Well" is present east of Death Valley Junction, California.

Drilling in similar earth materials for minerals exploration adjacent to regional spring areas is not without historic precedent in the Amargosa Basin. Further south in the basin near Tecopa Hot Springs, the Stauffer Chemical Company conducted drilling in 1967 in similar hydrogeologic conditions (see attachment B), and that drilling resulted in what is now termed "the Borehole."

THE BOREHOLE

The Borehole was initially an exploratory drill-hole that started in 1967 as an exploratory boring advanced by Stauffer Chemical that encountered water under pressure at a depth of approximately 360 feet (Partner Engineering and Science, 2020). Attempts were made to plug the boring, but water kept coming to the surface around each successive well seal, which also had the effect of creating a large void at depth. Attempts to seal the well were abandoned and what is known as "Borehole Spring" came into being. The void was eventually filled with 10,000 cubic yards of fill/gravel, although the flow was never completely contained. The feature is now a series of connected pools (and several non-connected pools) that discharges to the Grimshaw Lake area. A summary of the history of the Borehole is provided as Attachment B.

A result of the Borehole was a partial depressurization of the spring field surrounding Tecopa Hot Springs. Lowered groundwater levels and decreased spring discharge were initially reported in the area of Thom Spring at the south end of the Tecopa Hills, more than two miles south of the Borehole. Recent monitoring of the area indicates that conditions have continued to decline although at a much slower rate than originally encountered. Most recently, Thom Spring has decreased in flow to the point where surface waterhas not been present for more than one year. Monitoring of discharge in the Borehole area suggests that the system has not fully stabilized since the Borehole was completed decades earlier. The spring field along the eastern margin of the Tecopa Hills has been impacted by the Borehole, and it is likely that Tecopa Hot Springs discharge was also affected.

DISCUSSION

Exploratory drilling, whether for minerals or groundwater development, can present significant challenges. The term exploratory is indicative that conditions are not fully known when initiating the work. As shown above and by the well log presented, it is likely that not only may groundwater be encountered during drilling, but there is a possibility if not a likelihood, that artesian conditions will be encountered. As described in the Borehole example presented above, unanticipated conditions can be present, and these uncertainties present risks, including in the case of the currently proposed project, to the springs at the Refuge.

Borings to the northeast of Fairbanks and Longstreet Springs present additional risk. One dual completion well was constructed for the U.S. Department of Energy (Well log 46842) where the well was screened at depths from 240 to 412 ft bgs in the shallow tube and at depths greater than 1,000 feet for the deep tube. Artesian flow was also encountered. Unfortunately, the log does not specify whether the deep, the shallow, or both tubes/completions were exhibiting that artesian flow, and this substantial data gap precludes using this well for further consideration and is not included on the attached figure. Beyond this well, there are no wells to compare with proposed minerals exploratory drilling, leaving significant unknowns about anticipated conditions that may be encountered.

Based on the uncertainties with hydrogeologic conditions in the area of drilling, the proximity to Ash Meadows National Wildlife Refuge and its regional springs, and past experience in the Amargosa Basin near Tecopa Hot Springs related to the Borehole, we believe that the proposed mineral exploration drilling north of Ash Meadows presents considerable risk associated with resources in the Refuge.

If drilling is allowed to proceed regardless of the risks involved, a work plan prepared by Rover that identifies measures to control unanticipated artesian groundwater discharge that is protective of resources in the Refuge should be developed and presented in a detailed work plan. Such a work plan should be concerned with not only Fairbanks Springs, but other springs such as Longstreet Spring, Five Springs and others in the wildlife refuge that fall within a radius similar in size to the radius area of the impacts that were observed in the Borehole by Tecopa Hot Springs. The drilling company should be fully prepared, with materials on-hand, to address any issues that arise resulting from artesian conditions encountered during exploration drilling.

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