FINAL
EVALUATION OF
DEVELOPMENT ROCK PILES AT THE LA SAL MINES COMPLEX
SAN JUAN COUNTY, UTAH

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Acronyms

ATV	All terrain vehicle
BLM	U.S. Bureau of Land Management
Board	Utah Board of Oil, Gas, and Mining
CFR	U.S. Code of Federal Regulations
cm	centimeters
Denison	Denison Mines (USA) Corp.
DRA	Development rock area
EPA	U.S. Environmental Protection Agency
HELP	Hydrological evaluation of landfill performance
mg/kg	milligrams per kilogram
MSHA	U.S. Mine Safety and Health Administration
MWMP	Meteoric water mobility procedure
NOI	Notice of intention
POs	Plans of operation
RMC	Risk management criteria
RSL	Risk screening level
SU	Standard units
TDS	Total dissolved solids
UAC	Utah Administrative Code
UDOGM	Utah Division of Oil, Gas and Mining
USFS	U.S. Forest Service

Section 1
Introduction

1.1 Purpose of Report

The purpose of this report is to describe the geochemical characteristics of development rock areas (DRAs) present at the La Sal Mines Complex to support mine permitting activities. The La Sal Mines Complex is operated by Denison Mines (USA) Corp. (Denison) in accordance with approved Utah Notice of Intention (NOI) permits and U.S. Bureau of Land Management Plans of Operation (BLM POs). Denison is proposing to expand one DRA, which is located at the Pandora Mine on land administered by BLM. Expansion of this DRA will require modification of the BLM PO and the Utah NOI for the Pandora Mine.

Both Utah and BLM mine regulatory requirements address the potential for development rock to affect the environment, although the specific regulatory requirements are different. Development rock is rock that does not contain economic quantities of valuable metals, but that must be removed during the mining process to access ore. Development rock may contain minerals that can affect the environment, and therefore specific regulatory requirements have been developed to mitigate these risks during the permitting process. This investigation evaluates development rock at the La Sal Complex with respect to pertinent regulatory requirements, and provides specific information regarding the Pandora DRA to support modification to the BLM PO and the Utah NOI for the Pandora Mine.

1.2 Background Information

This section describes the location and general description of the La Sal Mines Complex facilities.

1.2.1 Location

The La Sal Mines complex is located in the vicinity of La Sal, Utah, on the south flank of the La Sal Mountains in San Juan County. The La Sal Mines Complex includes:

- The La Sal Mine;
- The Pandora Mine;
- The Snowball Mine; and
- The Beaver Shaft Mine;

A site location map is included as Figure 1-1.

1.2.2 General Description of Mine Facilities

The La Sal Mines Complex consists of a group of four underground uranium-vanadium mines. The mines all access the same ore body, and the underground workings of the mines are interconnected. Surface facilities are present at each of the

four mines, with an adit or shaft entry into the underground workings, surface support facilities, and one or more development rock areas.

1.3 Regulatory Framework

The regulatory framework at the La Sal Mines Complex includes state and federal permitting requirements. The distinction in permitting jurisdiction is based on the ownership of the surface and mineral estates that are affected by the existing and proposed mining operations. This framework can be described generally as follows:

- State mine permitting requirements are promulgated by the Utah Board of Oil, Gas, and Mining (Board) in accordance with the Utah Mined Land Reclamation Act and are administered by the Utah Division of Oil, Gas and Mining (UDOGM). These permitting requirements apply to all lands affected by the mining operation.

- Federal mine permitting requirements are promulgated by the U.S. Department of Interior and the U.S. Department of Agriculture in accordance with federal mining laws and are administered by the BLM and/the U.S. Forest Service (USFS) based on the land management agency responsible for managing the affected land. Federal mine permitting requirements are only applicable to lands where the mineral interest is reserved to the Unites States. Federal mine permitting requirements only apply to a portion of the La Sal mine complex.

1.3.1 Land Status

The existing and proposed affected areas of the La Sal Mines Complex include a variety of land ownership including private, state-owned lands, and federal lands managed by the BLM and USFS. Existing La Sal Mine Complex DRAs are present on private lands and federal lands administered by BLM. The proposed expansion to the DRA at the Pandora mine is located on federal lands administered by BLM.

1.3.2 Permit Status

Permitted DRAs are present at the Pandora Mine, Snowball Mine, La Sal Mine, and Beaver Shaft Mine area. Existing state permits for these facilities are Utah NOI M/037/012 (Pandora Mine) and M/037/026 (Snowball, La Sal and Beaver Shaft mines). Existing BLM POs for these facilities consist of Plan of Operation UT–060-GR-1-25, which applies to the Pandora Mine, and Plan of Operation UTU-060-GR-1-29, which apples to the portions of the Snowball, La Sal and Beaver Shaft operations that affect federal lands administered by BLM. Therefore, existing activities at the La Sal Mines Complex are permitted and approved activities as set forth by existing Utah and BLM permits.

Denison is proposing to expand the DRA at the Pandora Mine, and details of the proposed expansion and associated reclamation activities are available in *Plan of Operations Amendment Denison Mines (USA) Corp La Sal Mines Complex, San Juan County Utah* (Denison 2009). This planned expansion will affect approximately 4.7 acres of federal lands administered by BLM on the south side of the existing Pandora

DRA. The proposed DRA expansion is subject to both state and federal mine permitting regulations.

1.3.3 State Regulatory Requirements

This section describes Utah mine regulatory requirements pertinent to evaluation of development rock at the La Sal Mines Complex and management of potential deleterious materials produced at the mine sites. Deleterious materials are described broadly in Utah regulations (Utah Administrative Code (UAC) Section (§) R647-1-106) as:

"Deleterious Materials" means earth, waste or introduced materials exposed by mining operations to air, water, weather or microbiological processes, which would likely produce chemical or physical conditions in the soils or water that are detrimental to the biota or hydrologic systems

The regulations also include specific requirements for managing potential deleterious materials during the permitting, operations and reclamation phases.

- Operation Practices- All deleterious or potentially deleterious material shall be safely removed from the site or kept in an isolated condition such that adverse environmental effects are eliminated or controlled (UAC §R647-4-107); and

- Reclamation Plan- A description of the treatment, location and disposition of any deleterious or acid-forming materials generated and left on-site, including a map showing the location of such materials upon the completion of reclamation (UAC §R647-4-110);

- Reclamation Practices- All deleterious or potentially deleterious material shall be safely removed from the site or left in an isolated or neutralized condition such that adverse environmental effects are eliminated or controlled (UAC §R647-4-111).

Evaluation of the presence of deleterious materials at the Pandora DRA expansion area is addressed in Section 4 of this report to support modification of the state mine permit for the Pandora Mine (Utah NOI M/037/012).

1.3.4 Federal Regulatory Requirements

This section describes the BLM regulations pertinent to development rock as set forth at Title 43 Code of Federal Regulations (CFR) Section 3809 (3809 Regulations) and the applicability of these regulations to the existing and modified mine permits.

BLM 3809 Regulations

The 3809 Regulations broadly address prevention of unnecessary or undue degradation of public lands as follows: preventing unnecessary or undue degradation of public lands by operations authorized by the mining laws. Anyone intending to develop mineral resources on the public lands must prevent unnecessary or undue degradation of the land and reclaim disturbed areas (43 CFR §3809.1). BLM provides definition of unnecessary or undue degradation as follows (43 CFR § 3809.5):

> *Unnecessary or undue degradation means conditions, activities, or practices that:*
>
> *(1) Fail to comply with one or more of the following: the performance standards in § 3809.420, the terms and conditions of an approved plan of operations, operations described in a complete notice, and other Federal and state laws related to environmental protection and protection of cultural resources;*
>
> *(2) Are not ''reasonably incident'' to prospecting, mining, or processing operations as defined in §3715. 0–5 of this chapter; or*
>
> *(3) Fail to attain a stated level of protection or reclamation required by specific laws in areas such as the California Desert Conservation Area, Wild and Scenic Rivers, BLM-administered portions of the National Wilderness System, and BLM-administered National Monuments and National Conservation Areas.*

BLM also sets forth the requirements to prevent unnecessary or undue degradation (43 CFR §3809.415):

> *…You prevent unnecessary or undue degradation while conducting operations on public lands by— (a) Complying with § 3809.420, as applicable; the terms and conditions of your notice or approved plan of operations; and other Federal and State laws related to environmental protection and protection of cultural resources …*

The Performance Standards set forth at 43 CFR §3809.420 further define unnecessary or undue degradation and practices pertinent to management of development rock:

> *…Mining wastes. All tailings, dumps, deleterious materials or substances, and other waste produced by the operations shall be disposed of so as to prevent unnecessary or undue degradation and in accordance with applicable Federal and state Laws…* (43 CFR §3809.420(b)(2))
>
> *…Reclamation shall include, but shall not be limited to: ...(C) Measures to isolate, remove, or control toxic materials…* (43 CFR §3809.420(b)(3)(iii)(C))
>
> *…Water quality. All operators shall comply with applicable Federal and state water quality standards, including the Federal Water Pollution Control Act, as amended (30 U.S.C. 1151 et seq.)…* (43 CFR §3809.420(b)(5))
>
> *…Acid-forming, toxic, or other deleterious materials. You must incorporate identification, handling, and placement of potentially acid-forming, toxic or other deleterious materials into your operations, facility design, reclamation, and environmental monitoring programs to minimize the formation and impacts of acidic, alkaline, metalbearing, or other deleterious leachate.* (43 CFR §3809.420(b)(11))

Therefore, BLM regulations pertinent to development rock and DRAs relate to prevention of unnecessary or undue degradation to the environment via performance standards set forth in 43 CFR §3809.420, compliance with federal and state water quality standards, and compliance with other federal and state laws relating to environmental protection.

Applicability of 3809 Regulations to Existing and Modified Permits

As discussed previously, the existing activities at the La Sal Mine Complex are permitted by BLM Plans of Operations. The proposed expansion to the Pandora DRA is a modification to the existing Plan of Operations for the Pandora Mine (UT–060-GR-1-25). As set forth at 43 CFR §3809.433, the performance standards set forth at 43 CFR §3809.420 will apply to the expanded portion of the facility, while the terms of the existing Plan of Operations apply to the existing portion of the facility. The pertinent sections of 43 CFR §3809.433 are shown below:

Does this subpart apply to a new modification of my plan of operations?

To see how this subpart applies to a modification of your plan of operations that you submit to BLM after January 20, 2001, refer to the following table.

If you have an approved plan of operations on January 20, 2001	***Then:***
(a) New facility. You subsequently propose to modify your plan of operations by constructing a new facility, such as waste rock repository, leach pad, impoundment, drill site, or road.	*The plan contents requirements (§3809.401) and performance standards (§3809.420) of this subpart apply to the new facility. Those facilities and areas not included in the modification may continue to operate under the terms of your existing plan of operations.*
(b) Existing facility. You subsequently propose to modify your plan of operations by modifying an existing facility, such as expansion of a waste rock repository, leach pad, or impoundment; layback of a mine pit; or widening of a road.	*The plan contents requirements (§3809.401) and performance standards (§3809.420) of this subpart apply to the modified portion of the facility, unless you demonstrate to BLM's satisfaction it is not practical to apply them for economic environmental, safety, or technical reasons. If you make the demonstration, the plan content requirements (43 CFR 3809.1–5) and performance standards (43 CFR 3809.1–3(d) and 3809.2–2) that were in effect immediately before January 20, 2001 apply to your modified facility. (See 43 CFR parts 1000–end, revised as of Oct. 1, 2000.)*

1.4 Organization of Report

This report is organized as follows:

- Section 1: Introduction
- Section 2: Description of Existing Development Rock Areas
- Section 3: Evaluation of Proposed Expansion to Pandora Development Rock Area
- Section 4: Summary and Conclusions
- Section 5: References

Section 2
Description of Existing Development Rock Areas

2.1 General Characteristics of DRAs

DRAs are areas that are used for storage of rock produced during mining that does not contain a sufficient concentration of valuable metals to warrant mineral processing. Development rock is mined during advancement of tunnels and shafts in the underground mines to provide access to the ore. Some development rock can be left underground in tunnels and other underground voids, but a portion of the material must be hauled to the surface to allow for underground mine operations. Accordingly, DRAs are present at each of the four mines of the La Sal Mine Complex.

The four mines of the La Sal Mine Complex each excavate rock from the same uranium-vanadium mineral deposit, and the underground workings of the mines are interconnected. Each of the mines was developed over the past 50 years using similar mining methods. Therefore, the general characteristics of the development rock piles at the four mines are expected to be similar. However, there are several factors that can contribute to differences in the composition of the rock in the various DRAs. When an adit or a shaft is constructed, development rock is produced from geological formations that overlie the primary ore unit. The geological characteristics of rock units intersected by adits or shafts control the composition of the development rock produced during shaft or adit construction. After shaft and adit construction reached the uranium-vanadium host unit, development rock produced at the four mines is generally similar; however, variations in development rock produced over the life of the mine may be present as a result of variations in ore cut-off grades.

Mining at the La Sal Mines Complex is conducted entirely by underground mining methods. Underground mining produces far less development rock as compared to surface mining, which reduces the overall environmental impacts of underground mining as compared to surface mining. As a result, the size of current and future development rock areas at the La Sal Mines Complex is relatively small; each DRA is expected to be less than 7 acres upon mining completion. This reduces the overall footprint of the mining operation and reduces adverse environmental effects at the mines.

2.2 Existing Rock Areas at La Sal Complex

2.2.1 Pandora Mine

The DRA at the Pandora Mine is currently approximately 4.3 acres in size. It is located on the east side of a small ephemeral drainage as shown in Figure 2-1. The DRA has a current slope of approximately 30 to 35 degrees with an approximate height of 80 feet relative to the ground surface west of the pile. Development rock is currently brought to the surface at the portal located to the north-northwest of the DRA and placed on top of the DRA via haul trucks along a temporary access road.

2.2.2 Snowball Mine

The DRA at the Snowball Mine is currently approximately 3.3 acres in size. It is located south of the portal and east of the main access road to the mine as shown in Figure 2-2. The Snowball Mine is currently an inactive mine site; therefore, no additional development rock is being placed on the existing DRA. The DRA has a current slope of approximately 35 degrees with an approximate height of 40 feet relative to the ground surface to the south.

2.2.3 La Sal Mine

At the La Sal Mine site there are three separate DRAs. All DRAs are located east of the fuel storage area as shown in Figure 2-3. The La Sal Mine has temporarily ceased operations but may resume mining operation in the future. The northern, central, and southern DRAs are currently approximately 0.3, 0.5, and 1.3 acres in size, respectively. The northern DRA has a current slope of approximately 25 degrees while the two other DRAs have a current slope of approximately 35 degrees. The height of each DRA relative to the ground surface to the east is approximately 6 feet for the northern pile, 30 feet for the central pile, and 35 feet for the southern pile.

2.2.4 Beaver Shaft Mine

At the Beaver Shaft Mine site there are four separate DRAs, one east of the shaft area and three to the west as shown in Figure 2-4. The DRA to the west is currently approximately 2.4 acres in size and is accessed from a road that tees from the main access to the shaft site. The DRA has a current slope of approximately 15 to 20 degrees with an approximate height of 15 feet relative to the ground surface to the east. The three other DRAs west of the shaft are located along the west edge of the disturbed area. The northern, central, and southern DRAs are currently 0.6, 0.7, and 1.2 acres in size, respectively. The northern DRA has a current slope of approximately 20 degrees while the remaining two DRAs have a current slope of approximately 30 degrees. The height of each DRA relative to the ground surface to the west is approximately 10 feet for the northern pile, 14 feet for the central pile, and 30 feet for the southern pile.

Section 3
Evaluation of Proposed Expansion to Pandora Development Rock Area

Denison anticipates generating additional development rock to allow for further development of the underground mine workings and access to the ore body. As described in the *Plan of Operations Amendment Denison Mines (USA) Corp La Sal Mines Complex, San Juan County Utah* (Denison 2009), Denison anticipates production of approximately 200,000 additional cubic yards of development rock with the DRA expanding from its current 4.3 acres to approximately 7 acres. Detailed evaluation of the Pandora development rock geochemical characteristics was conducted to address permitting requirements associated with state and federal mine permitting laws. This section describes the data collection activities conducted at the Pandora DRA and addresses the potential for development rock to be a deleterious material as defined at UAC §R647-1-106 or to cause unnecessary or undue degradation as defined by 43 CFR §3809.5.

Acid mine drainage is a potential contributor to the presence of deleterious materials and to unnecessary or undue degradation at mine sites. Acid mine drainage is caused by the oxidation of sulfide minerals, and the absence of sufficient acid neutralizing minerals in mine rock to counteract acidity formed by sulfide minerals. The potential for the Pandora DRA to contribute to acid mine drainage was evaluated based on a field paste pH survey of the DRA, evaluation of the general mineralogy of the deposit, and consideration of historical information regarding the Pandora Mine.

The definitions of deleterious material set forth at UAC §R647-1-106 and unnecessary or undue degradation are general. Therefore, it is necessary to interpret the regulations in the context of the Pandora DRA to evaluate the rock. The following sections utilize the data collected to evaluate the following factors in considering the potential for the rock to be a deleterious material or to cause unnecessary or undue degradation:

- The potential for the development rock to cause acid rock drainage;
- The potential for the development rock to cause problematic leachate; and
- The potential for the rock to contain toxic metals at concentrations that could be considered direct contact human health or wildlife risks related to incidental ingestion or inhalation.

3.1 Field Sampling Activities

In July 2009, three development rock samples (RK-1, RK-2, and RK-3) were collected from the Pandora DRA. Two rock samples (RK-1 and RK-2) were collected from the upper surface of the DRA and one sample (RK-3) was collected from a cut bank area where development rock had been excavated previously exposing a cross-section through the rock pile. Samples at the surface were collected from pits excavated into

the rock pile using a hydraulic excavator. At each location, a multi-increment sample was developed with grab samples collected at depths ranging from the surface grade to approximately 12 feet below grade. The sample collected from the cut bank was a multi-increment sample collected across the width of the cut bank. Figure 3-1 shows the location of the Pandora DRA samples. Photographs of the Pandora DRA sample locations are included in Appendix A.

3.2 Potential Acid Mine Drainage Risk

Acid mine drainage is a potential contributor to the presence of deleterious materials and to unnecessary or undue degradation at mine sites. Acid mine drainage is caused by the oxidation of sulfide minerals, and the absence of sufficient acid neutralizing minerals in mine rock to counteract acidity formed by sulfide minerals. The potential for the Pandora DRA to contribute to acid mine drainage was evaluated based on a field paste pH survey of the DRA, evaluation of the general mineralogy of the deposit, and consideration of historical information regarding the Pandora Mine.

Evaluation of field paste pH is a method that is well-suited to evaluations of mine rock piles that have been in place for a period of years to decades. The Pandora mine pile was constructed over a period extending from the 1960's to the present, and therefore the paste pH method is useful to determine if rock in the pile is acid-generating. The paste pH method is based on addition of distilled water to a sample of fine grained rock from the DRA. The rock-water mixture is blended into a paste and the pH and total dissolved solids (TDS) concentration of the paste is measured in the field. Samples with strongly acidic pH and high TDS concentrations indicate that the rock is acid generating. Samples with paste pH of approximately 5.0 standard units (SU) and above are not considered acid generating.

The data from the field paste pH survey conducted at the Pandora DRA are presented in Table 3-1 and the location of paste pH samples are shown on Figure 3-1. Paste pH values range from 6.19 to 8.00 SU with a median value of 7.4 SU, which indicates that the Pandora DRA is not acid generating. Mineralogical information is also useful to evaluate the potential for the rock pile to generate acid mine drainage. Each sample analyzed for field paste pH was examined by hand lens to identify any potential sulfide minerals. No sulfide minerals were observed in any samples. This supports the conclusions of the paste pH sampling that the rock is not acid generating.

3.3 Potential Leachate Migration Risks

Although acid mine drainage is a major contributor to the presence of deleterious materials and unnecessary and undue environmental degradation at mine sites, under some conditions precipitation percolating though rock piles can cause problematic leachate even when acid mine drainage is not present. This section evaluates this risk at the Pandora DRA based on two factors:

- The potential for toxic metals or metalloids to leach from the rock in laboratory leach tests; and

- The potential for significant quantities of leachate to be developed at the DRA in relation to local climate conditions and other factors.

3.3.1 Laboratory Leaching Tests

Laboratory leaching tests were conducted on three composite samples collected from rock at the Pandora DRA. DRA samples were submitted to Energy Laboratories Inc. in Casper, Wyoming for analysis via the Meteoric Water Mobility Procedure (MWMP) (ASTM E2242-07). The specific procedure for the MWMP is attached as Appendix B. The method uses a column filled with rock collected from the DRA. Water at a 1:1 ratio by mass to the rock is percolated through the column over a 24 hour period, and the effluent from the column is collected and analyzed for metals and metalloids. This test measures the concentration of metals and metalloids released from the rock under the water to rock ratio of the test. The laboratory data for the MWMP tests are included in Appendix C.

A preliminary screening of the potential for the rock to generate leachate migration risks can be accomplished by comparing the metal and metalloid concentrations in the MWMP leachate to groundwater quality standards. Comparison of MWMP extract solution concentration to groundwater quality standards shown in UAC 317-6-2.2.1 is shown in Table 3-2. The data show that the leachate from the MWMP tests exceeds Utah groundwater quality standards for arsenic, selenium, uranium and nitrate. Arsenic, selenium, and uranium are naturally enriched elements in the rock, and nitrate is a residual product of ammonium nitrate fuel oil blasting agents. It should be noted that screening of the MWMP data with groundwater quality standards does not imply that there is a pathway from leachate from the DRA to affect groundwater, or that adverse groundwater effects will occur.

The MWMP data show that the rock has the potential to generate problematic leachate if hydrological conditions including climate and other site-specific hydrological factors are sufficient to cause leachate to occur from the pile. The Pandora Mine is located in a semi-arid environment where evaporation significantly exceeds precipitation. Evaluation of the potential for precipitation to percolate through the pile is addressed in the following section.

3.3.2 Potential for Percolation

Unsaturated flow modeling was used to estimate percolation through the DRA. UNSAT-H (Fayer 2000) is a Fortran-based model that is used to simulate the one-dimensional flow of water and vapor in soils. The code addresses the processes of precipitation, evaporation, storage, and deep drainage. The procedure for this estimation included:

- Approximate physical and hydrological characteristics of development rock using data from a nearby mine, which extracts the same rock types as present at the Pandora Mine.

- Compile climate data from representative locations as close as possible to the site.

- Estimate percolation through development rock areas using UNSAT-H.

The UNSAT-H model was chosen for this evaluation because it simulates both downward movement of water into the development rock piles during infiltration and upward movement of water from the rock piles caused by evaporation. Consideration of upward unsaturated flow is critical for accurate simulation of percolation through mine rock piles in semiarid and arid environments (Swanson et al. 2000). Application of rigorous unsaturated flow models based on Richard's equation is becoming a widely used approach to simulate unsaturated flow through mine development piles (e.g. Ford et al, 2000; Swanson et al., 2000, Fala et al., 2005). Benson et al. (2006) provides basic requirements for unsaturated flow models including:

- The model must simulate unsaturated flow in a rigorous manner (i.e. must solve Richards equation);
- The model must include a surface boundary simulating soil-atmosphere interactions (precipitation, infiltration, evaporation, runoff); and
- The model must integrate climatic data into the solution.

UNSAT-H meets these requirements. Although the U.S. Environmental Protection Agency (EPA) Hydrological Evaluation of Landfill Performance model (HELP) has been used in the past for these types of estimates, HELP does not meet the criterion of rigorously simulating upward movement of water through the vadose zone through application of Richard's equation (Benson et al. 2006). UNSAT-H also is capable of simulating heat flow and plant transpiration, although these options were not applied in this estimation.

Additional details of the calculation methods and procedure applied by UNSAT-H are presented in Fayer (2000) and are not discussed further in this document. A calculation brief, model input files, input data tables, and model output files are presented as Appendix D. The calculation brief provides a summary of the modeling approach including description of model nodes and boundary conditions, description of climate data sources, and definition of soil characteristics.

Exhibit 3-1 is a summary of modeling results effort for the Pandora Mine DRA on an annual basis. Additional detail, including daily percolation estimates are included in Appendix D. The estimate was completed for average annual precipitation (33.8 centimeters (cm)) and the wettest year on record (51.0 cm).

Exhibit 3-1. Summary of UNSAT-H modeling results

Model Run	Annual Potential Evap. (cm)	Annual Precipitation (cm)	Annual Actual Evap. (cm)	Annual Runoff (cm)	Annual Infiltration (cm)	Annual Percolation (cm)
Average Precipitation	190.005	33.807	33.733	0	33.807	0.0071394
Wettest year on Record	190.005	51.029	42.482	2.8643	48.164	0. 0074589

Based on the UNSAT-H simulations, the estimated percolation through the rock piles is estimated to be approximately 0.007 cm per year. The simulations show the importance of evaluating upward movement of water from the rock piles caused by evaporation because the majority of water that infiltrates the surface of the development rock piles evaporates in the semi-arid environment. The simulations show that the rock pile gains moisture during the wettest year on record, but that the moisture storage capacity within the pile is adequate to store this additional moisture until it evaporates, restricting downward percolation.

The UNSAT-H simulations suggest that significant percolation from the base of the development rock piles is unlikely. However, a small amount of percolation is estimated for all simulations.

The simulations further suggest that infiltration of precipitation followed by upward evaporative flux of water stored within the development rock areas are dominant mechanisms controlling the volume of percolation through the development rock areas.

The results of the UNSAT-H simulations correspond to the input parameters including the development rock physical and hydrologic parameters, and the available climate data. Site-specific climate data are not available, and differences between actual climate conditions at the site and the data compiled from the La Sal, Blanding and Grand Junction weather stations could result in variations in estimated percolation through the piles. In addition, site-specific data were not available for physical and hydrological characteristics of the Pandora rock pile, and data from a similar rock pile at the Sunday Mines Complex in Colorado were used. Potential variations in physical and hydrological characteristics between the modeled pile and the Pandora rock pile also contribute to uncertainty in the UNSAT-H models.

3.4 Potential Direct Contact Risks

As described previously, DRAs at the La Sal Complex are located on federal lands managed by BLM. This screening-level evaluation is based on comparison of the total metals concentrations detected in development rock samples with appropriate screening criteria developed by BLM for metals in soils in the guidance document titled, Risk Based Criteria for Metals at BLM Mining Sites (BLM 2004). This BLM

document provides risk management criteria (RMC) for human exposure to soils for various land uses on BLM property including residents, campers, all terrain vehicle (ATV) drivers, workers, and surveyors. In addition, BLM has developed RMCs for wildlife and livestock for ecological risk management on BLM property. The BLM RMC values support land management of former mine sites and are used as a benchmark concentration to which environmental concentrations may be compared, assisting land managers in protecting humans and wildlife on BLM lands. In particular, BLM RMC values were developed such that "people will not experience adverse health effects from metal contamination on BLM lands during their lifetimes if exposure is limited to soil… with concentrations at or less than the RMC" (BLM 2004, p. 3).

BLM RMCs have not been identified for several site-specific metals of interest at the Pandora DRA including uranium. In order to assess the potential toxicity of the following metals in development rock and ore, EPA Regional Screening Levels (RSL; EPA 2008) for a commercial/industrial exposure scenario were utilized as screening level concentrations: aluminum, barium, beryllium, boron, calcium, chromium, cobalt, iron, lithium, magnesium, molybdenum, phosphorus, potassium, silicon, sodium, strontium, thallium, tin, titanium, uranium and vanadium.

Although the commercial/industrial exposure scenario is not the same as the expected post-mining land use of the property (e.g., non-motorized recreation), the exposure concentrations provided in this scenario are conservative; that is, the scenario provides additional human health exposure to metals on the site (e.g., hours of exposure per year for a worker) than what is anticipated given the anticipated post-mining land use. Similar to RMCs, EPA RSLs have been developed using conservative exposure assumptions and represent levels that are protective of human health for most site conditions (EPA 1996). For example, the use of screening criteria for an industrial land use is very conservative for the Pandora DRA, because it assumes exposure for 250 days per year over 25 years.

It should be noted that direct contact risks to miners are not evaluated as part of this assessment because these risks are regulated by the U.S. Mine Safety and Health Administration (MSHA) in accordance with the federal Mine Safety and Health Act of 1977 as amended, and other federal laws and regulations. Denison's mining operations comply with these regulations.

3.4.1 Screening-Level Evaluation

Total metals data (EPA Method 6010B/6020) from development rock samples were compared to screening levels to assess potential direct contact risks to humans and wildlife. Table 3-3 provides a summary of total metals concentrations in the Pandora development rock compared to corresponding BLM RMC and EPA RSLs. With respect to human health screening levels, the only detected metal with a concentration that exceeds its respective screening value is arsenic. With the exception of arsenic, this screening level evaluation indicates that development rock is not problematic with respect to human health direct contact risks.

The total metals data are also compared to BLM wildlife RMC values. The BLM RMCs are species-specific, and this screening-level evaluation considers RMC values for deer mouse, cottontail, bighorn sheep, white-tailed deer, mule deer, elk, cattle, and sheep. The screening-level evaluation shows that most metals in development rock occur at concentrations that are lower than their respective screening criteria. However, one of the three samples exceeded wildlife screening values for cadmium, lead and zinc, and two of the three samples exceeded the screening level for lead. Although local areas may be present where cadmium, lead, and zinc concentrations exceed the BLM screening levels, potential toxicity to wildlife are not discussed further in this document for several reasons:

- The development rock areas where cadmium, lead and zinc locally exceed the wildlife screening criteria are very small relative to home and/or foraging ranges for most ecological receptors of interest, which reduces the potential exposure levels.
- Threatened or endangered species, or suitable habitat for those species, are not present in the Pandora DRA.
- It is unlikely that potential adverse effects to wildlife related to direct contact risks would cause a significant impact to overall populations and community of the referenced species.

3.4.2 Further Assessment of Arsenic in Development Rock

As discussed in the BLM document and consistent with screening level approaches, site-specific data can be used to reduce uncertainties in the exposure assumptions used to develop the RMCs (BLM 2004, p. 13). In particular, to further evaluate detected concentrations of arsenic in development rock and its potential to cause risks to workers, RMC input parameters were adjusted using site-specific information regarding exposure to multiple metals and media.

RMCs have been calculated based on potential for both non-cancer and cancer health effects. Health protective levels for arsenic are 65 and 12 milligrams per kilogram (mg/kg) for non-cancer and cancer health effects, respectively. For non-cancer health effects, BLM RMCs have been divided by 11 metals and "n" media to account for multiple chemical and media exposures. Such a calculation is conservative for the Pandora Mine because most metals are present only at concentrations well below their respective RMCs indicating little if any potential for adverse health effects. Even so, all arsenic concentrations are below the non-cancer "RMC" of 65 mg/kg. From a non-cancer viewpoint, development rock at the Pandora Mine is not problematic with respect to direct contact risks.

RMCs based on cancer risk assume possible exposure to arsenic in groundwater, soil and air and the number of media included in the calculations is therefore three (3). Thus, the RMC for arsenic in soil is about one third of the value that would be calculated assuming exposure to soil alone. In a telephone correspondence with Dr. Karl Ford of the BLM (author of the BLM RMC document), (CDM 2009), Dr. Ford

indicated that the appropriate number of media for the worker scenario was one (1). This input to the calculations is appropriate because:

1. Groundwater is present only at depth and no contact with groundwater is possible for a worker or camper that visits the site;

2. Possible exposure to arsenic suspended as dust in ambient air is estimated in the equation for calculation of the RMC based on cancer risk; and

3. Possible exposure to other carcinogens observed in development rock (cadmium and nickel) is accounted for in the calculations.

Further, inputs to the calculations, as provided by Dr. Ford in telephone correspondence (CDM 2009), imply that a worker visiting the site will accidentally ingest 114 mg of fine material from the development rock piles per day. This ingestion rate is high compared to a typical commercial/industrial worker (50 mg/day) and thus accounts for increased ingestion during short-term, relatively intense contact with soil during weed or fire control activities. [1] Overall, a site-specific RMC for arsenic based on cancer risk can reasonably be recalculated using Dr. Ford's suggested input of one (1) for number of media. A site specific RMC for arsenic was therefore recalculated as:

$$RMC = C_s = \frac{TR \cdot AT \cdot 365}{\left[EF \cdot M_N \cdot \left\{(SF_o \cdot CF \cdot IR_s) + \left(\frac{SF_I}{M_N} \cdot IR \cdot \left(\frac{1}{PEF}\right)\right)\right\}\right]}$$

Where:

- C_s = Chemical Risk Management Criteria in Soil (mg/kg)
- TR = Target Excess Individual Lifetime Cancer Risk — 1 (unit less)
- AT = Carcinogenic Averaging Time — 25,550 days
- EF = Exposure Frequency — 40 days/year
- SF_o = Oral Carcinogenic Potency Slope — 1.5 $(mg/kg\text{-}day)^{-1}$
- CF = Conversion Factor — $1x10^{-6}$ kg/mg
- M_N = Number of Media — 1 (unit less)
- IR_s = Age Adjusted Soil Ingestion Rate — 114 (mg-year/kg-day)

[1] Media include soil, air, groundwater, sediment and surface water. Only soil and air are relevant to the Pandora Mine, as discussed in the text.

- SF_i = Inhalation Carcinogenic Potency Slope 15 $(mg/kg\text{-}day)^{-1}$
- IR = Inhalation Rate 2.5 m^3/day
- PEF = Particulate Emission Factor 4.63×10^{-9} m^3/kg

This equation, when used with the above exposure assumptions for workers, yields a criterion for arsenic of 37 mg/kg for protection from carcinogenic health effects; an upwards revision from the guidance document criteria of 12 mg/kg.

Arsenic concentrations of the three development rock samples collected from the Pandora DRA were 25.0, 7.5 and 40.9 mg/kg respectively. The average of these three samples is 24.5 mg/kg, which is well below the 37 mg/kg screening criterion described above. The highest concentration of the three samples of 40.9 mg/kg was slightly above the 37 mg/kg screening criterion.

Section 4
Summary and Conclusions

The purpose of this report is to describe the geochemical characteristics of development rock at the La Sal Mines complex in relation to pertinent state and BLM mine permitting regulations. Development rock is present at all mines in the La Sal complex. Development rock is rock that must be excavated to provide access to ore, but that does not contain sufficient quantities of valuable metals to warrant mineral processing. Both state and BLM mine permitting regulations require evaluation of development rock. The applicability of state and federal mine permitting regulations is dependent on the land status of the DRA as well as the permit status. State permitting regulations apply to all DRAs at the La Sal Mines Complex. BLM permitting requirements as set forth at 43 CFR 3809 apply to all DRAs located on land administered by the BLM. However, the performance standards of 43 CFR §3809.420 and the Plan of Operations completeness requirements of 43 CFR §3809.401 do not apply to DRAs permitted before January 20, 2001. These facilities are subject to the terms and conditions of the existing BLM Plans of Operations. New DRAs or expansions to existing DRAs are subject to the performance standards of 43 CFR 43 CFR §3809.420 and the Plan of Operation completeness requirements of 43 CFR §3809.401.

This investigation evaluated the Pandora DRA in detail because this facility is subject to a proposed expansion, and it is therefore subject to the performance standards of 43 CFR 43 CFR §3809.420 and the Plan of Operations completeness requirements of 43 CFR §3809.401. This proposed facility is also subject to state mine permitting regulations. However, the general characteristics of all DRAs at the La Sal Mines Complex are likely to be similar, because the mines all access the same ore body within the Salt Wash Member of the Morrison Formation. (J. Showalter, Denison Mine Geologist, personal communication 2009) and were generated using similar mining practices. Variations in characteristics of the DRAs may be present as a result of the rock units that were intersected during development of adits or shafts at the respective mines and variations in ore cut-off grades at the time of the mine development activities.

Rock at the Pandora DRA was evaluated for three potential environmental issues to address identification of potentially deleterious materials as defined in state mine permitting regulations and prevention of unnecessary or undue environmental degradation in accordance with BLM mining regulations. These issues consist of:

- Potential for the rock to generate acid mine drainage;
- Potential for the rock to generate problematic leachate; and
- Potential for the rock to contribute to risks related to incidental ingestion or inhalation.

The potential for the Pandora rock to generate acid rock drainage was evaluated through completion of a field paste pH survey and field examination of rock

mineralogy using a hand lens. The data indicate that the rock does not have the potential to generate acid mine drainage.

The potential for rock at the Pandora DRA to generate problematic leachate was evaluated by completion of MWMP tests and evaluation of the likelihood of significant percolation from the rock pile. The MWMP tests suggest that the rock could produce leachate that contained problematic concentrations of deleterious substances if climate and rock pile conditions were condusive to production of significant leachate. However, unsaturated flow modeling using UNSAT-H suggests that is unlikely that significant leachate will be produced from the DRA. The UNSAT-H simulations predict an annual percolation rate of only 0.007 cm per year.

Screening of the potential for the rock pile to contribute to risks, related to direct inhalation or ingestion, were conducted by comparing total metals analyses to BLM and EPA screening criteria. The evaluation indicates that the rock does not contain concentrations of uranium, vanadium or numerous other metals at concentrations that would cause risks to humans related to incidental ingestion or inhalation. However, the rock does contain concentrations of arsenic that exceed the BLM screening criteria. Therefore, additional evaluation of the potential for the rock to pose risks related to incidental ingestion and inhalation of arsenic were completed.

The additional evaluation of potential arsenic risks consisted of examination of the assumptions used in calculation of the standard BLM screening criterion for arsenic in relation to site-specific factors. These site specific factors were included in recalculation of the screening criteria, which is common practice in risk assessments. Recalculation provides a more representative site-specific evaluation of potential risks. Incorporation of site-specific factors in evaluation of risk indicates that the average concentration of the arsenic samples does not exceed the risk threshold for direct contact and incidental ingestion hazards. However, one of the three samples did exceed the site-specific screening criterion.

The average arsenic concentration of the Pandora DRA samples does not pose risks, but it is possible that local portions of the La Sal Complex DRAs could present potential direct contact risks during the post-reclamation period and may require mitigation during reclamation. Denison has developed a management plan to be implemented during reclamation to address this risk. This plan is presented in the *Plan of Operations Amendment Denison Mines (USA) Corp La Sal Mines Complex, San Juan County Utah (2009)*. The plan includes the following:

- Evaluation of exposed development rock for local areas that present potential direct contact risks;
- Mitigation of any areas of development rock that pose potential post-reclamation risks by covering with inert material or selective excavation and placement in the underground mine.

It should also be noted that reclamation of the DRAs will include placement of topsoil over development rock and establishment of vegetation. This process will also mitigate the potential presence of local areas that could cause risks related to incidental ingestion or inhalation during the post-reclamation period.

Section 5
References

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Figures

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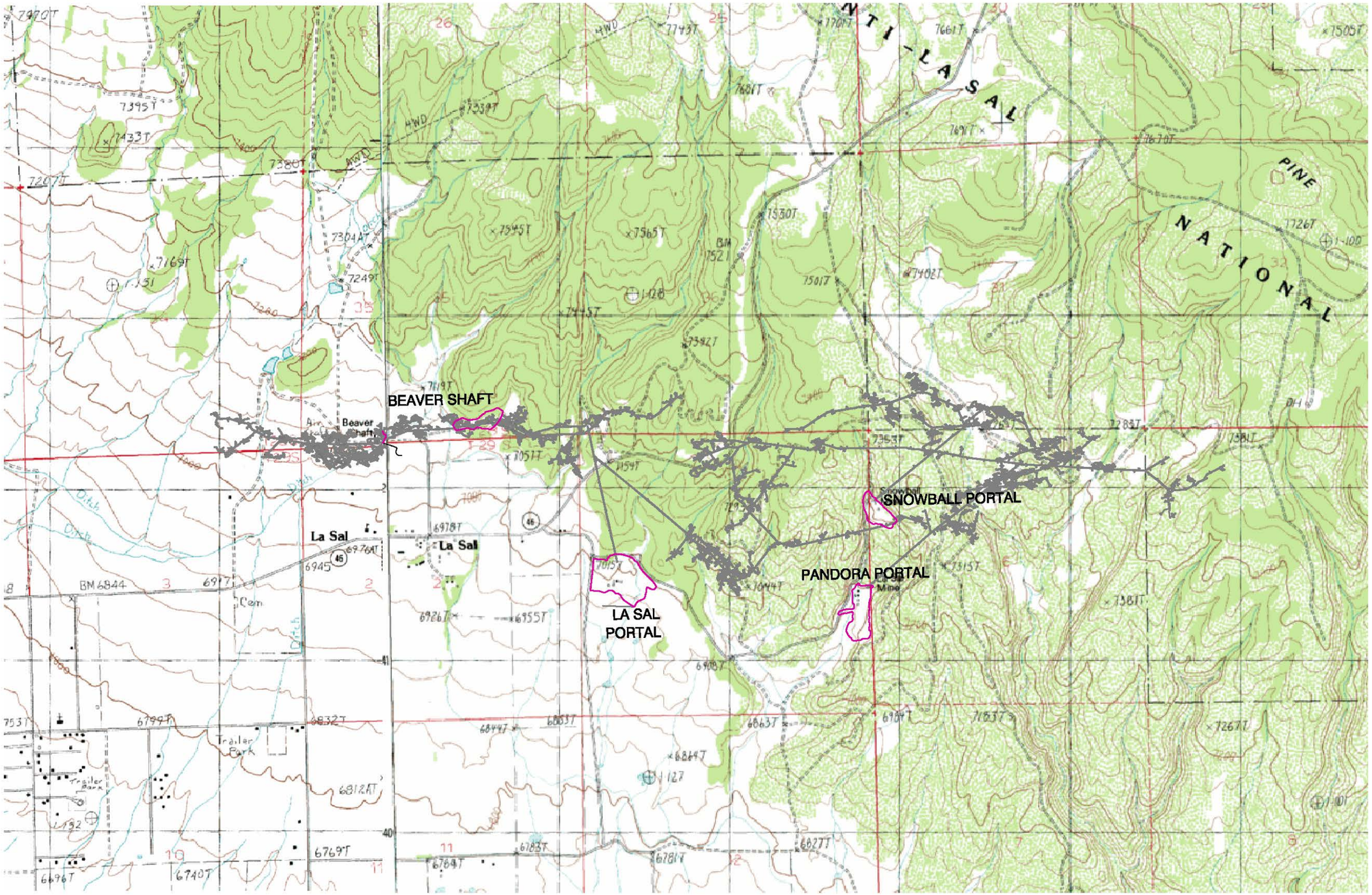

N

LEGEND:

APPROXIMATE DISTURBED AREA

TOPOGRAPHIC CONTOUR (MSL) INTERVAL = 20 FT

UNDERGROUND WORKINGS

0 2000' 4000'

SCALE IN FEET

CDM

Figure 1-1
La Sal Mines Complex
Site Location map

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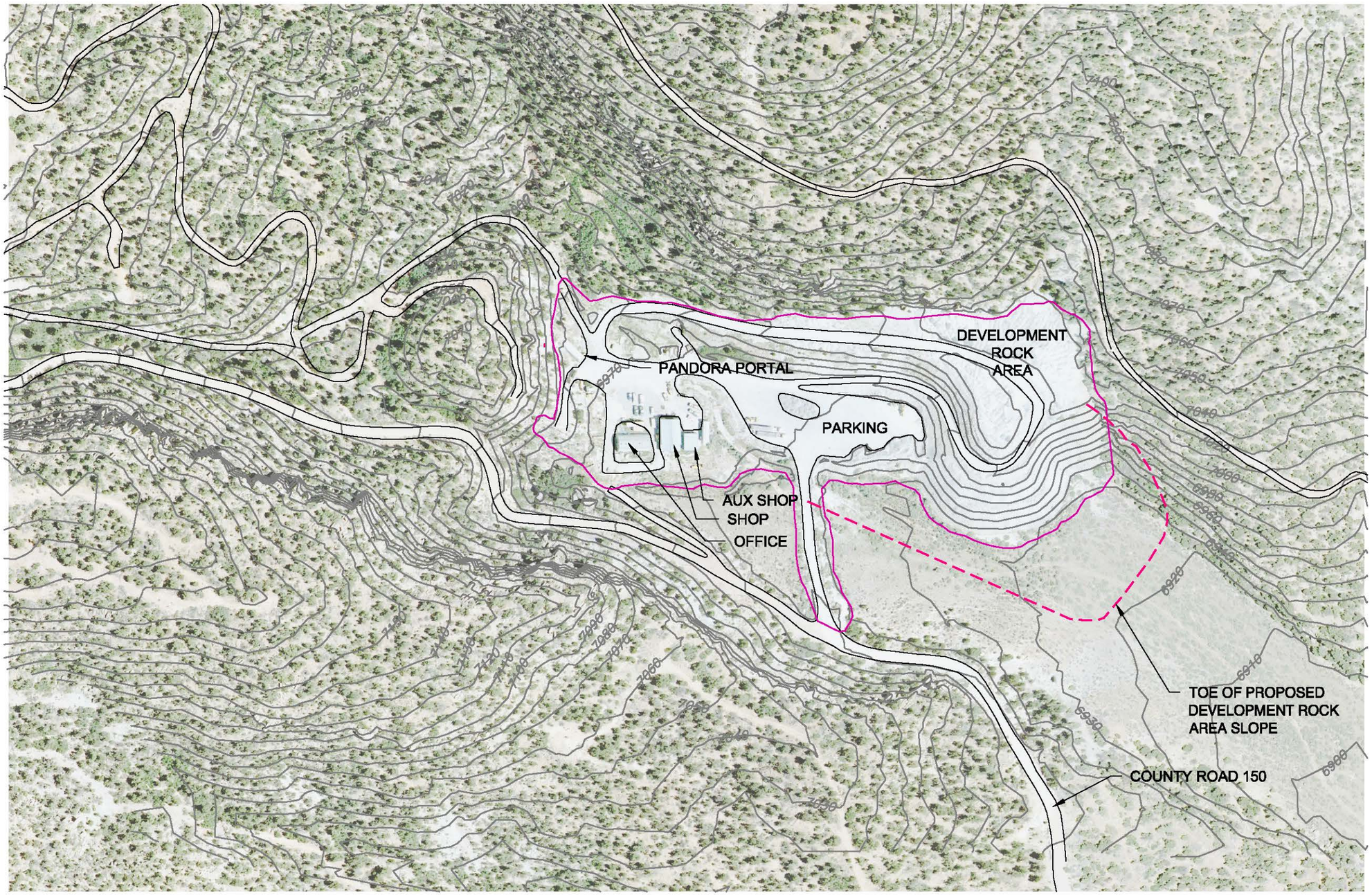

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LEGEND:

APPROXIMATE DISTURBED AREA

6920 TOPOGRAPHIC CONTOUR (MSL) INTERVAL = 10 FT

EXISTING ROAD

0 200' 400'

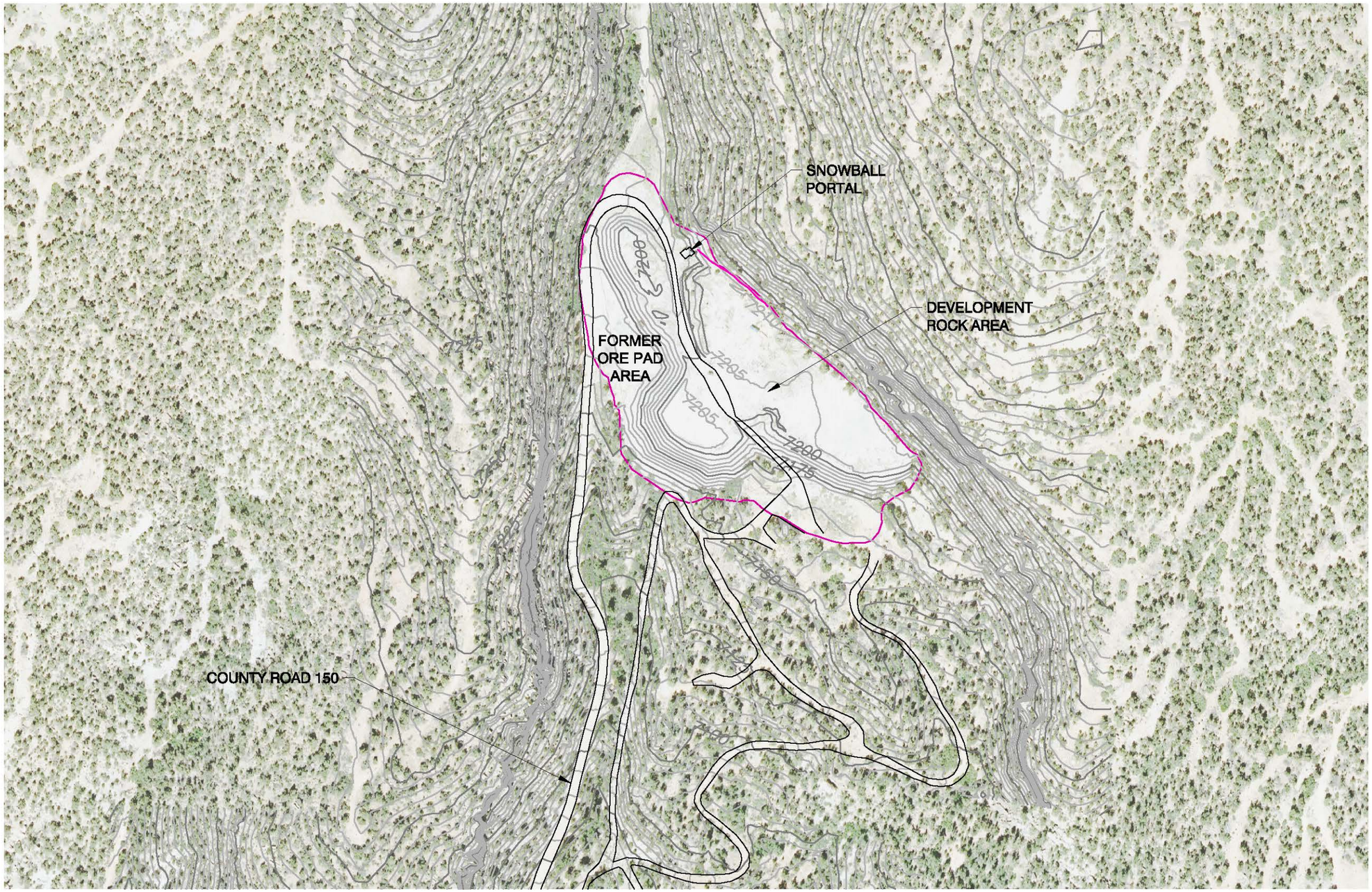
SCALE IN FEET

AERIAL IMAGE: DENISON MINE AERIAL SURVEY, 2008

CDM

Figure 2-1
Pandora Mine Area
Site Map

X:\64986-Denison Mines\Snowball\CIVL\ CSTPL-001RR 12/08/09 18:48 HUMPHREYJL XREFS: pandoraribs81209, Topo-2ft_Pandora-Snowball, CSTPL-100



N

LEGEND:

APPROXIMATE DISTURBED AREA

7200 TOPOGRAPHIC CONTOUR (MSL) INTERVAL = 5 FT

EXISTING ROAD

0 200' 400'

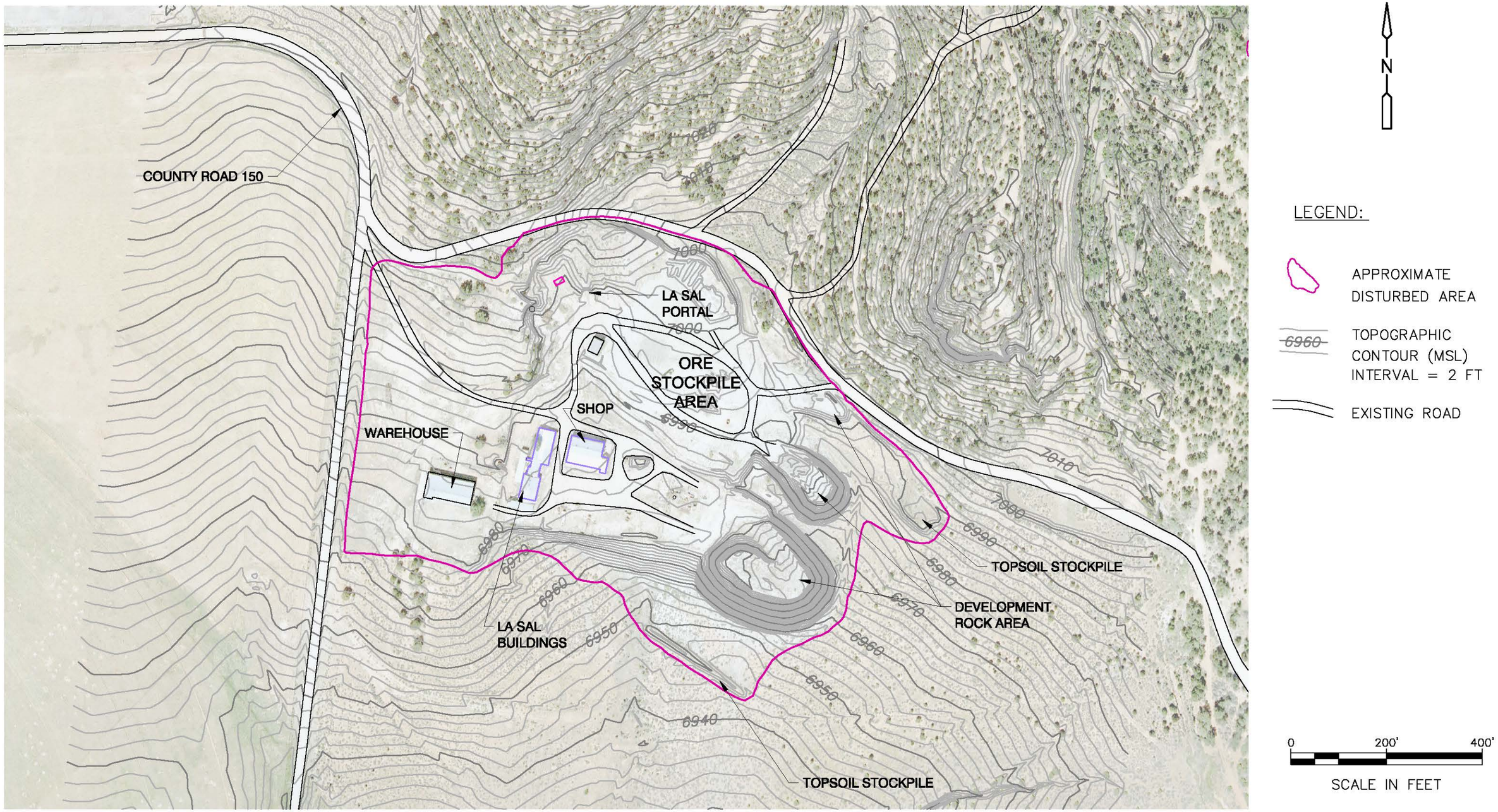
SCALE IN FEET

AERIAL IMAGE: DENISON MINE AERIAL SURVEY, 2008

CDM

Figure 2-2
Snowball Mine Area
Site Map

X:\64986-Denison Mines\LaSal Mine\CIVL\ CSTPL-001RR 12/08/09 19:01 HUMPHREYJL XREFS: pandoraribs81209, Topo-2ft_LaSal, CSTPL100

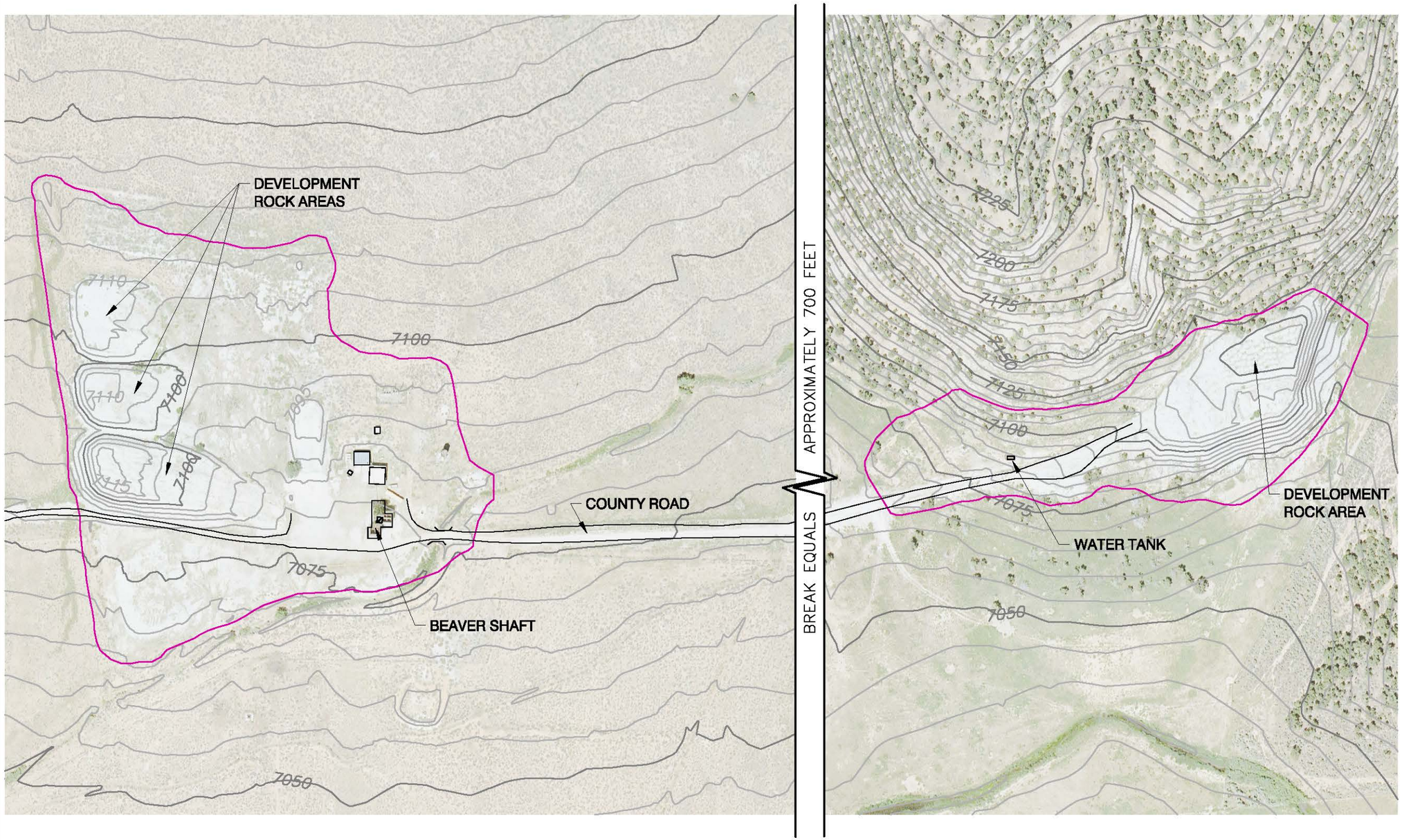


AERIAL IMAGE: DENISON MINE AERIAL SURVEY, 2008

CDM

Figure 2-3
LaSal Mine Area
Site Map

X:\64986-Denison Mines\Beaver Shaft\CIVL\ CSTPL-001RR 12/08/09 19:20 HUMPHREYJL XREFS: pandoraribs81209, CSTPL100



N

LEGEND:

APPROXIMATE DISTURBED AREA

7050 TOPOGRAPHIC CONTOUR (MSL) INTERVAL = 5 FT

EXISTING ROAD

0 200' 400'

SCALE IN FEET

AERIAL IMAGE: DENISON MINE AERIAL SURVEY, 2008

CDM

Figure 2-4
Beaver Shaft Mine Area
Site Map

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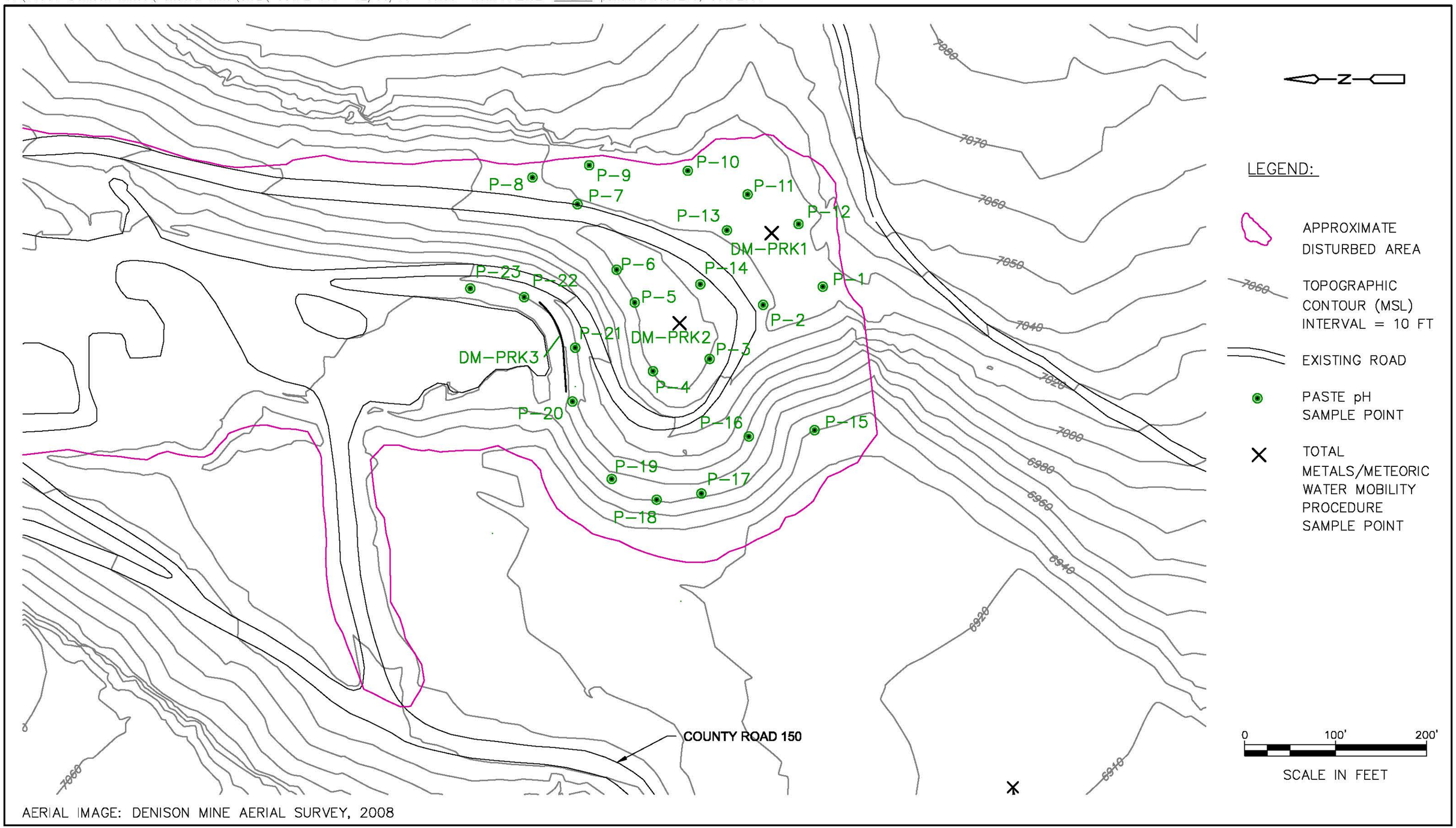

CDM

Figure 3-1
Pandora Development Rock Area
Sample Location Map

Tables

Table 3-1
Pandora Mine Paste pH Data

Sample	Paste pH (SU)	Paste TDS (ppt)	Lithologic Description
P-1	7.09	1.2	medium grained sandstone, well sorted, moderately rounded, light gray
P-2	7.81	0.6	lithology as above, trace black uranium-vanadium minerals
P-3	7.83	0.7	light gray sandstone, medium grained, moderately sorted, moderately rounded
P-4	7.94	0.4	80% gray sandstone as above, 20% fine grained sandstone, dark grey color
P-5	8	1	90% gray sandstone, medium grained, moderately sorted, moderately rounded; 10% fine grained sandstone, dark gray
P-6	7.4	0.7	gray sandstone, medium grained, moderately sorted, moderately rounded
P-7	7.86	1	gray sand (ground up sandstone from traffic) moderately to poorly sorted, medium grained
P-8	7.95	0.6	gray sand as above
P-9	7.55	0.6	tan colored sandstone, fine grained, well sorted, moderately rounded
P-10	7.3	1.1	50% dark gray siltstone, well sorted. Moderately rounded; 50% gray sandstone, medium grained, moderately sorted, moderately rounded
P-11	7.49	0.7	lithology as above, 60% sandstone, 40% siltstone
P-12	7.83	0.7	gray sandstone, medium grained, moderately sorted, moderately rounded
P-13	7.93	0.7	gray sandstone as above
P-14	7.16	0.3	Gray sandstone as above
P-15	7.62	0.4	tan sandstone, medium grained, well sorted, moderately rounded, looks to be more weathered version of gray sandstone sampled above
P-16	6.9	0.2	tan sandstone, med grained,, moderately sorted, moderately rounded, mostly quartz, ~3% reddish brown feldspar
P-17	6.37	0.2	tan sandstone as above, trace iron oxide in local zones on weathered surfaces
P-18	7.1	0.1	tan sandstone as above, trace black to yellow-green uranium-vanadium minerals, trace iron oxide on weathered surfaces
P-19	6.19	0.1	medium grained sandstone, moderately sorted, moderately rounded
P-20	7.14	0.6	tan sandstone, medium grained, well sorted, moderately rounded
P-21	6.51	0.8	light gray sandstone, medium grained, well sorted, moderately rounded, trace fine grained disseminated uranium-vanadium minerals, local cobbles with more abundant uranium-vanadium mineralization
P-22	6.52	0.4	medium grained sandstone, well sorted, well rounded
P-23	6.83	0.5	sandstone as above

notes:
SU- standard units
PPT- parts per thousand

Table 3-2
Comparison of Pandora Mine Meteoric Water Mobility Procedure Data with Groundwater Quality Standards

Analyte	Unit	Screening Criteria: Utah GWQS	DM-P RK-1	Q	E	DM-P RK-2	Q	E	DM-P RK-3	Q	E
Major Ions											
Calcium	mg/L	---	98			91			213		
Chloride	mg/L	---	6.49			23.9			31.9		
Fluoride	mg/L	4	0.43			0.38			0.59		
Magnesium	mg/L	---	67			50			100		
Nitrogen, Ammonia as N	mg/L	---	26.9	D		52.5	D		2.37		
Nitrogen, Nitrate + Nitrite as N	mg/L	10	104		*	52.5		*	105		*
Nitrogen, Nitrate as N	mg/L	10	103		*	51.7		*	104		*
Nitrogen, Nitrite as N	mg/L	1	0.663			0.758			1.18		*
Sulfate	mg/L	---	622			509			774		
Non-Metals											
Oxidation-Reduction Potential	mV	---	234			230			241		
Radionuclides											
Gross Alpha	pCi/L		1050			844			634		
Gross Beta	pCi/L		238			181			146		
Physical Properties											
Conductivity	umhos/cm	---	2020			1580			2320		
Hardness as CaCO3	mg/L	---	523			433			946		
Oxygen, Dissolved	mg/L	---	6.3			7.3			7.2		
pH	s.u.	6.5 to 8.5	7.09			7.25			7.79		
Total Dissolved Solids	mg/L	---	1380			1070			1870		
Metals											
Aluminum, Dissolved	mg/L	---	0.1	U		0.1	U		0.1	U	
Aluminum, Total Recoverable		---	0.626			0.1	U		0.1	U	
Antimony, Dissolved	mg/L	0.006	0.006			0.006			0.005		
Arsenic, Dissolved	mg/L	0.05	0.201		*	0.154		*	0.219		*
Barium, Dissolved	mg/L	2	0.054			0.055			0.049		
Beryllium, Dissolved	mg/L	0.004	0.001	U		0.001	U		0.001	U	
Boron, Dissolved	mg/L	---	0.1	U		0.1	U		0.1	U	
Cadmium, Dissolved	mg/L	0.005	0.001	U		0.002			0.002		
Chromium, Dissolved	mg/L	0.1	0.001	U		0.001	U		0.001	U	
Cobalt, Dissolved	mg/L	---	0.018			0.012			0.009		
Copper, Dissolved	mg/L	1.3	0.006			0.006			0.007		
Iron, Dissolved	mg/L	---	0.03	U		0.03	U		0.03	U	
Iron, Total Recoverable	mg/L	---	0.185			0.03	U		0.03	U	
Lead, Dissolved	mg/L	0.015	0.001	U		0.001	U		0.001	U	
Lithium, Dissolved	mg/L	---	0.104			0.1	U		0.1		
Manganese, Dissolved	mg/L	---	0.162			0.141			0.11		
Mercury, Dissolved	mg/L	0.002	0.001	U		0.001	U		0.001	U	
Mercury, Total Recoverable	mg/L	0.002	0.001	U		0.001	U		0.001	U	
Molybdenum, Dissolved	mg/L	---	0.688			2.44			2.09		
Nickel, Dissolved	mg/L	---	0.012			0.008			0.008		
Selenium, Dissolved	mg/L	0.05	0.673		*	0.769		*	1.21		*
Silver, Dissolved	mg/L	0.1	0.001	U		0.001	U		0.001	U	
Thallium, Dissolved	mg/L	0.002	0.001			0.001			0.001	U	
Uranium, Dissolved	mg/L	0.03	0.527		*	0.33		*	0.356		*
Vanadium, Dissolved	mg/L	---	5.4			3.11			3.53		
Zinc, Dissolved	mg/L	5	0.01			0.012			0.014		

Key:

Q = Lab Qualifier, U = Non Detect, E = Exceedance, mg/L = milligrams per liter, s.u. = standard units, umhos/cm = micromhos per centimeter, GWQS = Groundwater Quality Standards,

D = Reporting limit increased due to sample matrix interference

Notes:

1. * Indicates that sample concentration exceeds groundwater quality standard.
2. All samples collected on July 23, 2009.
3. Groundwater Quality Standards from Table 1 of the Utah Administrative Code Rule R317-6-2-2.1.

Table 3-3
Comparison of Pandora MineTotal Metals Data to Screening Levels

Analyte	BLM Soil Screening Criteria[1]					EPA Industrial Soil Screening Level (SSL)[2]	Pandora Mine Total Metals Data and Comparison to Screening Levels																							
	Camper	ATV Driver	Worker	Surveyor	Wildlife/Livestock		RK-1	Lab Qualifier	BLM Camper	BLM ATV Driver	BLM Worker	BLM Surveyor	BLM Wildlife/Livestock	EPA Industrial	RK-2	Lab Qualifier	BLM Camper	BLM ATV Driver	BLM Worker	BLM Surveyor	BLM Wildlife/Livestock	EPA Industrial	RK-3	Lab Qualifier	BLM Camper	BLM ATV Driver	BLM Worker	BLM Surveyor	BLM Wildlife/Livestock	EPA Industrial
Aluminum						990,000	1550	D							1080	D							2470	D						
Antimony	50	750	100	600		na	0.5	U						na	0.5	U						na	0.5	U						na
Arsenic	20	300	12	100	200	na	25		*		*			na	7.5							na	40.9		*		*			na
Barium						190,000	95.3								121								114							
Beryllium						2,000	0.5	U							0.5	U							0.5	U						
Boron						200,000	6.4								5	U							5	U						
Cadmium	70	950	100	800	3	na	3.1						*	na	0.6							na	2.9							na
Calcium							13100								13500								13600							
Chromium[3]						200	3.3								4.8								3.4							
Cobalt						300	2.5								1.8								4.3							
Copper	5,000	70,000	7,400	59,000	64	na	8.3							na	16							na	54.2							na
Iron						720,000	2550	D							1930	D							4790	D						
Lead	1,000	1,000	2,000	2,000	106	na	159						*	na	74.3							na	395						*	na
Lithium							10	U							10	U							10	U						
Magnesium							2540								2680								3370							
Manganese	19,000	250,000	28,000	220,000		na	204							na	204							na	231							na
Mercury	40	550	60	480	2	na	0.05	U						na	0.05	U						na	0.05	U						na
Molybdenum							29.7								5.7								27.5							
Nickel	2,700	38,000	4,000	32,000		na	2.8							na	1.8							na	3.4							na
Phosphorus							147								121								174							
Potassium							941								713								1230							
Selenium	700	9,600	1,000	8,000		na	22.6							na	11.1							na	31.9							na
Silica							1200								1150								1690							
Silver	700	9,600	1,000	8,000		na	0.7							na	0.5	U						na	0.8							na
Sodium							21.5	D							10.04	U_D							244	D						
Strontium							27.2								23.4								44.3							
Thallium						66	0.5	U							0.5	U							0.5	U						
Tin						610,000	1.2								1								1							
Titanium							29.5								12.2								34.6							
Uranium						3,100	149								44.8								160							
Vanadium						5,200	342								187								443							
Zinc	40,000	550,000	60,000	480,000	222	na	366						*	na	65.1							na	187							na

Notes:

All concentrations shown are in units of mg/kg.

* - Indicates that sample concentration exceeds respective screening criteria.

na - Screening value not applicable because more appropriate BLM screening criteria available

D - Reporting limit increased due to sample matrix interference.

U - Non-detect result. Value shown is equal to the reporting limit.

1 - BLM Soil Screening Criteria were obtained from *Risk Management Criteria for Metals at BLM Mining Sites, U.S. Department of Interior, Bureau of Land Management, Technical Note 390 rev., October 2004, Table 2, Human Risk Management Criteria and Table 4, Wildlife and Livestock Risk Management Criteria for Metals in Soils.*

Values for wildlife/livestock screening criteria indicated are the most stringent of the screening criteria for Deer Mouse, Cottontail, Bighorn Sheep, White-Tailed Deer, Mule Deer, Elk, Cattle, and Sheep.

2 - EPA Industrial Screening Criteria are applied only to analytes are not included in BLM screening criteria and were obtained from a combination of EPA Region 3 risk based concentrations (RBCs), Region 6 Human Health Medium-Specific Screening Levels (HHMSSLs), and the Region 9 Preliminary Remediation Goals (PRGs). Values from all of these tables has been combined in an online database by EPA that can be found at the following location: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm.

3. Chromium criteria shown are for chromium VI (particulates).

APPENDIX A

Photographs of Pandora Sampling

Before we began taking samples, the excavator was cleaned of any debris and possible contaminants.	

Some of the equipment used during the sampling.	

Mark Nelson conducting a paste PH test at a sample point at the face of the waste rock pile.	

A great deal of effort was taken to lessen the possibility of any cross contamination between test points.	

This is a pic of the waste rock pile that was tested. This also shows the area of proposed expansion at the base of the pile where several soil samples were taken.	

bobcat

bobcat

bobcat

APPENDIX B

Meteoric Water Mobility Procedure

Designation: E 2242 – 07

Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure[1]

This standard is issued under the fixed designation E 2242; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method provides a procedure for the column percolation extraction of mine rock in order to determine the potential for dissolution and mobility of certain constituents by meteoric water.

1.2 This test method is intended to describe the procedure for performing column percolation extractions only. It does not describe all types of sampling and analytical requirements that may be associated with its application.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 1193 Specification for Reagent Water

D 1293 Test Methods for pH of Water

D 6234 Test Method for Shake Extraction of Mining Waste by the Synthetic Precipitation Leaching Procedure

E 50 Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials

E 135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials

E 389 Test Method for Particle Size or Screen Analysis at No. 4 (4.75-mm) Sieve and Coarser for Metal-Bearing Ores and Related Materials

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E 877 Practice for Sampling and Sample Preparation of Iron Ores and Related Materials

E 882 Guide for Accountability and Quality Control in the Chemical Analysis Laboratory

E 1601 Practice for Conducting an Interlaboratory Study to Evaluate the Performance of an Analytical Method

2.2 *Other References:*

Meteoric Water Mobility Procedure, Bureau of Mining Regulation and Reclamation, Nevada Division of Environmental Protection, 9/19/90

Standard Methods for the Examination of Water and Wastewater, 18th edition, APHA/AWWA/WEF, 1992

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology E 135.

3.1.1 *meteoric water*—rainfall that has the potential to contact materials and mobilize soluble constituents from mine rock at a mining or mineral processing site.

3.1.2 *mine rock*—ore, waste rock or overburden excavated in order to recover metals or minerals during mining operations or coarse processed ore such as heap leach spoils.

4. Summary of Test Method

4.1 The test material is placed in a plastic column and contacted with an equal weight of water during a 24 h leaching period. The extract is collected and preserved for analysis of inorganic constituents.

5. Significance and Use

5.1 This test method is intended as a means for obtaining an extract from mine rock samples. The extract may be used to estimate the final pH and release of certain constituents of the test sample under the laboratory conditions described in this test method.

5.2 The pH of the extraction fluid used in this test method should reflect the pH of precipitation in the geographic region in which the mine rock is being evaluated.

[1] This test method is under the jurisdiction of ASTM Committee E01 on Analytical Chemistry for Metals, Ores and Related Materials and is the direct responsibility of Subcommittee E01.02 on Ores, Concentrates, and Related Metallurgical Materials.

Current edition approved June 1, 2007. Published June 2007. Originally approved in 2002. Last previous edition approved in 2002 as E 2242 – 02.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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5.3 This test method is designed to mobilize potential contaminants present in the solids, so that the resulting extract can be used to assess leachate that could potentially be produced from mine rock in the field.

5.4 This test method has not been demonstrated to simulate actual site leaching conditions.

5.5 This test method produces extracts that are amenable to the determination of both major and minor (trace) constituents. When minor constituents are being determined, it is especially important that precautions be taken in sample preservation, storage and handling to avoid possible contamination of the extracts.

5.6 This test method is a comparative method intended for use as a routine method for monitoring mine rock. It is assumed that all who use this method will be trained analysts capable of performing skillfully and safely. It is expected that work will be performed in a properly equipped laboratory under appropriate quality control practices such as those described in Guide E 882.

6. Interferences

6.1 This test method may not be suitable for obtaining extracts from finely divided solids (such as: finely crushed drill cuttings, clays, sludges, mill tailings, etc.), due to difficulty in obtaining a representative extract solution. If it takes more than 48 h for the column to produce an extract which has a mass equivalent to 70 % of the dry test sample weight, use of an alternate extraction procedure may be required, such as Method D 6234.

7. Apparatus

7.1 *Drying Pans or Dishes*, for moisture content determinations, 1 kg capacity.

7.2 *Extraction Column*, PVC column of 15-cm (6-in.) O.D. of sufficient height to contain a minimum of 5 kg of test sample with a feed particle size that just passes a 5-cm (2-in.) sieve and sufficient additional height to contain applied water volume should poor percolation occur. For a 5 kg test sample, a 15 cm O.D. × 45 cm high column is recommended. Additional column height will be required for test sample quantities greater than 5 kg. The bottom of the column must be sealed and a solution discharge outlet situated above the sealed bottom of the column and below a perforated support plate. A drawing of a suitable extraction column is shown in Fig. 1.

7.3 *Filtration Device*, of a composition suitable to the nature of the analyses to be performed and equipped with a 0.45 µm pore size filter. An assembly for pre-filtration or a centrifuge may be required if 0.45 µm filtration is difficult.

7.4 *Filter Media*, glass wool (inert) or a plastic fiber pad is placed onto the support plate before loading the laboratory sample into the column, to minimize fines migration, and onto the top of the test sample after column loading, to aid in making an even water distribution.

7.5 *Laboratory Balance*, capable of weighing to 1.0 g.

7.6 *pH Meter*, with a readability of 0.01 units and an accuracy of at least ± 0.05 units at 25 °C.

7.7 *Tubing*, surgical or synthetic tubing sufficient in diameter and length for the extraction column assembly (pump, column outlet).

7.8 *Water and Extract Containers*, sufficient in size to contain the water added during extraction. Containers must be covered to avoid contamination.

7.9 *Water Metering Device*, a metering pump or constant head device to insure constant rate extraction fluid application during column percolation.

8. Reagents and Materials

8.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[3] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

8.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean Type II reagent water at 18 °C to 27 °C conforming to Specification D 1193.

9. Hazards

9.1 For precautions to be observed in the use of analytical methods associated with this standard, refer to Practices E 50.

10. Sampling and Sample Preparation

10.1 The amount of gross sample to be sent to the laboratory should he sufficient to perform the solids content determination as specified in 10.3, and to provide at least 5 kg of test sample on a dry weight basis for extraction. Gross sample weights in the range of 7 to 25 kg are appropriate.

NOTE 1—Information on obtaining representative samples can also be found in Pierre Gy's Sampling Theory and Sampling Practice[4] and in Practice E 877.

10.2 In order to prevent sample contamination or constituent loss prior to extraction, keep the samples in closed containers appropriate to sample type and desired analysis.

10.3 *Moisture Determination*—Remove the gross sample from the container and blend by coning or rolling to obtain a sample for feed moisture content with a minimum of 500 g dry weight.

10.3.1 Weigh the moisture test sample and dry to constant weight (± 0.05 %) at 105 °C ± 2 °C and record the weight.

10.3.2 Calculate the moisture content of the test sample as follows:

$$M = \frac{100(B - A)}{B} \quad (1)$$

[3] *Reagent Chemicals, American Chemical Society Specifications* , American Chemical Society, Washington. DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

[4] Pitard, F., *Pierre Gy's Sampling Theory and Sampling Practice*, Vols. I and II, CRC Press, 1989.

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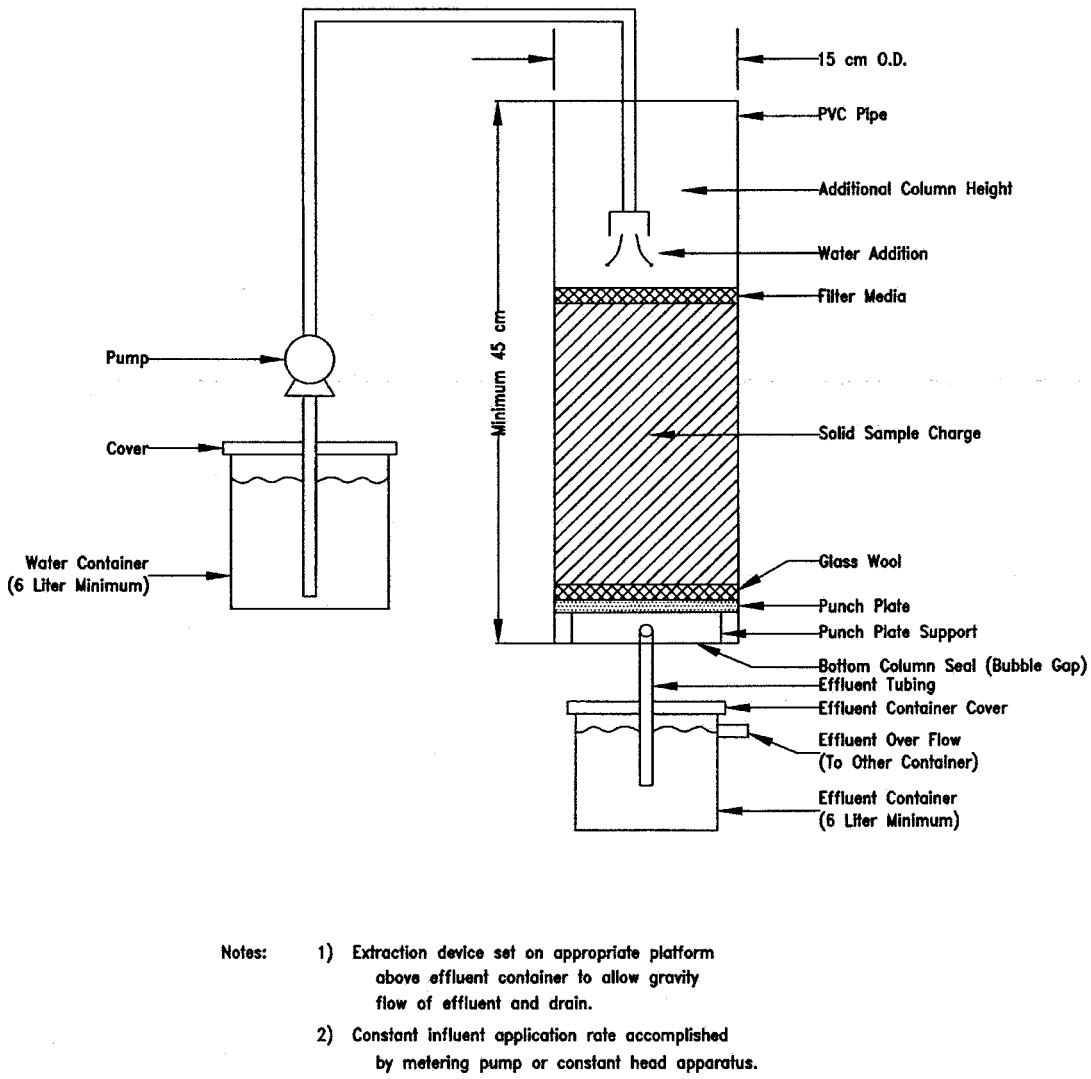

FIG. 1 Column Percolation Extraction Device (Meteoric Water Mobility Procedure)

where:
A = mass of sample after drying, g,
B = wet mass of sample, g, and
M = moisture content, %.

10.4 Separate the remaining laboratory sample on a 5-cm (2-in.) sieve. Save the minus 5-cm fraction for recombination with the crushed plus 5-cm fraction. The screening time or end point is when additional periods of shaking fail to change the results by more than 0.3 % (Method E 389). For highly friable material an acceptable end point shall be determined experimentally.

10.5 Weigh the plus and minus 5-cm sieve fractions, calculate and record the weight percent retained on the 5-cm sieve as follows:

$$R = \frac{100C}{(C + D)} \tag{2}$$

where:
R = weight retained on the 5-cm sieve, %,
C = mass retained on the 5-cm sieve, g, and
D = mass passing the 5-cm sieve, g.

10.6 Crush or hand break the materials retained on the 5-cm sieve so that they just pass through the 5-cm (2-in.) sieve, combine with the saved fraction passed through the 5-cm sieve and mix the prepared sample.

10.7 Thoroughly blend the prepared sample and calculate the minimum test sample weight containing 5 kg dry weight, based on the feed moisture content from 10.3, as follows:

$$S = \frac{5 \times 10^5}{(100 - M)} \tag{3}$$

where:

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S = minimum sample mass for testing, g and
M = moisture content, %.

10.8 Divide the prepared sample, if necessary, to obtain a test sample suitable for processing in the column apparatus but not less than the minimum sample weight from 10.7. and weigh to ± 1 g. Label and reserve any excess prepared sample for any additional testing which may be required.

10.9 Calculate the dry weight of the test sample as follows:

$$L = \frac{E(100 - M)}{100} \quad (4)$$

where:
L = dry mass of the test sample, g,
E = gross mass of the test sample, g, and
M = moisture content of the gross sample, %.

11. Procedure

11.1 Place filter media (7.4) in the bottom of the extraction column and load the laboratory sample incrementally (~1-kg/increment) into the column. To minimize particle segregation and compaction during column loading, the sample portions shall be dropped from no more than 0.6 m (24 in.) when introduced from the top of the column, and no tamping, shaking, or other methods to compact the sample will be employed. Place filter media over the test sample in the column.

11.2 Use a water addition rate of 3.5 mL/min for minimum weight samples in the range of 5 to 5.5 kg dry weight.

11.2.1 For samples greater than 5.5 kg dry weight, calculate the rate of water addition to the column to pass a weight of water equal to the dry weight of the test sample during the 24 h test period as follows:

$$F = \frac{L}{1440} \quad (5)$$

where:
F = water addition rate, mL/min, and
L = dry mass of the laboratory sample, g.

11.3 Measure and record the initial temperature and pH of the leaching water in accordance with Test Methods D 1293. Record the time and date that water addition is started.

11.4 Add water to the column at the rate specified in 11.2 until the weight of the effluent is equal to the dry mass of the laboratory sample. If the water will not freely percolate through the column, abort the test and repeat the evaluation using an alternate testing procedure, such as Test Method D 6234.

11.5 Discontinue water addition and effluent collection when the effluent weight is equal to the dry weight of the test sample or 48 h has elapsed, which ever occurs first. If, after 48 h, the effluent weight is not at least 70 % of the dry weight of the test sample, abort the test and select an alternate testing method for the sample, such as Test Method D 6234.

11.6 Thoroughly mix the effluent and let the column effluent continue to drain into a waste container.

11.7 Immediately measure and record the final pH of the effluent in accordance with Test Methods D 1293. Record the date, time and final effluent weight.

11.8 *Extract*—Quantitatively transfer a 2-L portion of the effluent through a large glass funnel to a filtration device equipped with a 0.45 µm filter for analyses of dissolved constituents. Pre-filtration using a coarse porosity glass filter and centrifuge separation procedures may be necessary prior to filtration for some difficult to filter effluents. Immediately measure and record the final pH of the extract in accordance with Test Methods D 1293. Record the final effluent and extract weights.

11.8.1 Retain a 250-mL portion of the extract for metals analysis with its pH adjusted to less than 2 with nitric acid.

11.8.2 Retain a 250-mL portion of the extract for nutrients analysis with its pH adjusted to less than 2 with sulfuric acid.

11.8.3 Retain a 1-L portion of the extract for cyanide analysis with its pH adjusted to between 12 and 12.5 with sodium hydroxide. Store in a dark bottle at 4 °C ± 2 °C, if the cyanide analysis is not performed immediately.

11.8.4 Refrigerate the remaining extract at 4 °C ± 2 °C for mineral analyses.

11.9 Analyze the unfiltered effluent for specific constituents or properties, or use for biological testing procedures as necessary.

11.10 Analyses should be performed using appropriate ASTM test methods. Where no appropriate ASTM test methods exist, other test methods may be used, such as Standard Methods for the Examination of Water and Wastewater, and record the methods used in the report. Whether visible phase separation during storage of the extract or effluent occurs or not, appropriate mixing should be used to ensure the homogeneity of the extract and effluent prior to their use in such analyses or testing.

11.11 Allow the remaining column effluent to drain until at least two minutes elapses between drops of effluent from the test column. There should be no apparent free water phase in the column at the end of the draining period. Record any visual changes in the column residue, extract or effluent which occurred during the test period.

11.12 Remove the test residue from the column and blend by coning or rolling and obtain a sample of at least 500 g for residual moisture content. Determine the residual moisture as in 10.3 and record the results. Reserve the residue for any additional testing required.

12. Report

12.1 Report the following information:

12.1.1 Source of the gross sample, date of sampling, methods of sampling and sample preservation, storage conditions, handling procedures, and length of time between sample collection and extraction;

TABLE 1 Statistical Information—Test Variables

Material	Number of Labs	Variable	Mean	Measurement Units
Mine Waste Rock	8	Time	27.5	Hours
Heap Leach Spoils	8	Time	26.7	Hours
Mine Waste Rock	8	Temperature	21.7	Degrees C
Heap Leach Spoils	8	Temperature	21.8	Degrees C
Mine Waste Rock	8	Volume	4.99	Liters
Heap Leach Spoils	8	Volume	5.05	Liters

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TABLE 2 Statistical Information—Individual Laboratory Analyses

Material	Number of Labs	Analyte	Mean	Measurement Units	Repeatability Standard Deviation (s_r, E 691)	Reproducibility Standard Deviation (s_R, E 691)	Repeatability (r, E 691)	Reproducibility (R, E 691)	%R
Mine Waste Rock	8	Moisture	18.0	% H_2O	0.691	1.31	1.93	3.68	20
Heap Leach Spoils	8	Moisture	11.7	% H_2O	0.388	1.11	1.09	3.11	27
Mine Waste Rock	8	Water pH	5.61	pH	Not Applicable	Not Applicable			
Heap Leach Spoils	8	Water pH	5.61	pH	Not Applicable	Not Applicable			
Mine Waste Rock	8	Effluent pH	2.79	pH	0.0561	0.122	0.157	0.341	12
Heap Leach Spoils	8	Effluent pH	8.43	pH	0.101	0.265	0.282	0.741	9
Mine Waste Rock	8	Extract pH	2.81	pH	0.074	0.142	0.206	0.398	14
Heap Leach Spoils	8	Extract pH	8.37	pH	0.101	0.368	0.284	1.030	12
Mine Waste Rock	8	Acidity	506	µg/g	44.5	115	125	321	63[A]
Heap Leach Spoils	8	Alkalinity	81.4	µg/g	10.5	12.4	29.3	34.7	43
Mine Waste Rock	8	Dissolved Solids	1130	µg/g	175	262	490	734	65[A]
Heap Leach Spoils	8	Dissolved Solids	671	µg/g	69.9	79.8	196	224	33

[A] Not Quantitative.

TABLE 3 Statistical Information—Central Laboratory Analyses

Material	Number of Labs	Analyte	Mean	Measurement Units	Repeatability Standard Deviation (s_r, E 691)	Reproducibility Standard Deviation (s_R, E 691)	Repeatability (r, E 691)	Reproducibility (R, E 691)	%R
Mine Waste Rock	8	Aluminum	43.0	µg/g	3.30	6.83	9.23	19.1	44
Heap Leach Spoils	8	Aluminum	0.0858	µg/g	0.0464	0.0800	0.13	0.221	258[A]
Heap Leach Spoils	8	Arsenic	0.238	µg/g	0.0236	0.0306	0.0660	0.0856	36
Mine Waste Rock	8	Barium	0.0252	µg/g	0.00301	0.00758	0.00843	0.0212	84[A]
Heap Leach Spoils	8	Barium	0.0406	µg/g	0.0178	0.0303	0.0500	0.0847	209[A]
Heap Leach Spoils	8	Boron	0.323	µg/g	0.0177	0.0368	0.0495	0.103	32
Mine Waste Rock	8	Cobalt	0.0599	µg/g	0.0078	0.0105	0.0215	0.0295	49
Heap Leach Spoils	8	Cobalt	0.1020	µg/g	0.00921	0.0105	0.0258	0.0295	29
Mine Waste Rock	8	Chromium	0.0953	µg/g	0.00968	0.0193	0.0271	0.0541	57[A]
Mine Waste Rock	8	Copper	2.38	µg/g	0.208	0.458	0.581	1.28	54[A]
Mine Waste Rock	8	Iron	39.3	µg/g	3.31	9.47	9.26	26.53	68[A]
Heap Leach Spoils	8	Iron	0.148	µg/g	0.0336	0.0401	0.0942	0.112	76[A]
Mine Waste Rock	8	Potassium	5.06	µg/g	0.890	1.61	2.49	4.5	89[A]
Heap Leach Spoils	8	Potassium	7.01	µg/g	0.281	0.470	0.786	1.32	19
Mine Waste Rock	8	Lithium	0.0804	µg/g	0.0074	0.0092	0.0207	0.0259	32
Heap Leach Spoils	8	Lithium	0.0495	µg/g	0.00218	0.00322	0.0061	0.00902	18
Mine Waste Rock	8	Magnesium	18.0	µg/g	1.37	2.67	3.83	7.49	42
Heap Leach Spoils	8	Magnesium	5.40	µg/g	0.542	0.542	1.52	1.52	28
Mine Waste Rock	8	Manganese	3.83	µg/g	0.333	0.589	0.931	1.65	43
Heap Leach Spoils	8	Molybdenum	0.0514	µg/g	0.00347	0.0057	0.0097	0.0159	31
Mine Waste Rock	8	Sodium	5.62	µg/g	1.21	1.69	3.39	4.73	84[A]
Heap Leach Spoils	8	Sodium	138	µg/g	7.50	10.7	21.0	29.8	22
Mine Waste Rock	8	Nickel	0.245	µg/g	0.0187	0.0400	0.0529	0.112	46
Mine Waste Rock	8	Lead	2.71	µg/g	0.117	0.260	0.328	0.727	27
Mine Waste Rock	8	Strontium	0.286	µg/g	0.0276	0.0367	0.0773	0.103	36
Heap Leach Spoils	8	Strontium	0.563	µg/g	0.0553	0.0553	0.155	0.155	28
Heap Leach Spoils	8	Vanadium	0.0388	µg/g	0.00261	0.00593	0.00731	0.0166	43
Mine Waste Rock	8	Zinc	21.8	µg/g	1.90	3.68	5.33	10.3	47

[A] Not Quantitative.

12.1.2 Moisture content (10.3), time and temperature used in the determination of the moisture content and results from any analyses performed on other splits of the laboratory sample;

12.1.3 Description of the gross sample, including its physical characteristics and sieve analysis results (10.5);

12.1.4 Weight of the test sample on a wet and dry basis;

12.1.5 The pH of the water used for the extraction;

12.1.6 Water application rate, temperature, extraction time, effluent pH and the final effluent weight;

12.1.7 Filter pore size used and filter composition;

12.1.8 Use of a centrifuge or pre-filter, the pre-filter pore size and composition;

12.1.9 Observations of changes in the test material or leaching solution (11.11);

12.1.10 The final weight and pH of the extract, and the results of specific analyses;

12.1.11 Moisture content of the residue, time and temperature used in the determination of the moisture content, and results of any analyses performed on the residue; and

12.1.12 Dates on which extraction was started and completed, preservation used for extract portions, and dates of analyses. A detailed laboratory worksheet that may be helpful in performing the test method is shown in Fig. 2.

13. Precision and Bias

13.1 *Precision*—Eight laboratories cooperated in testing this method and obtained the precision data summarized in Tables 1-3.[5] The interlaboratory testing was planned according to Practice E 1601, following Test Plan A for destructive test

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: E01-1037.

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Figure 2. Laboratory Worksheet

Sample Description:

Moisture sample after drying, g : = _____

Moisture sample before drying, g : = _____

Drying temperature and time, : = _____

Moisture Content, % : = _____

Sieve retained weight (+5 cm), g := _____

Sieve passing weight (-5 cm), g := _____

Retained percent (+5 cm):= _____

Wet test sample, g : = _____

Dry test sample, g : = _____

Rate of water addition, mL/min : = _____

pH of extraction water : = _____

Extraction time and temperature: = _____

pH of final effluent : = _____

Final effluent, g : = _____

Filter type and pore size: = _____

pH of extract : = _____

Extract, g : = _____

Residue sample after drying, g : = _____

Residue sample before drying, g : = _____

Drying temperature and time, : = _____

Residue moisture, % : = _____

Observations:

FIG. 2 Laboratory Worksheet

methods with single analyses for duplicate test materials, rather than three or more test portions with triplicate analyses, because of the decision to perform most of the analytical work in one central laboratory. The objective of the test was not to measure the precision of the analytical methods but to determine the precision of the column extraction procedure. The Practice E 691 computer program was used to calculate the statistics.

13.1.1 The analyses conducted immediately by the individual laboratories showed precision in the quantitative range with the exception of acidity and dissolved solids for the mine waste rock, which exceeded the quantitative limit for *R* of 50 %. Many of the solution analyses conducted by the central laboratory could not be used for statistical purposes, since they were reported to be below detection. The precision of many analyses in the central laboratory also were not within the quantitative range even at relatively high concentrations, so the user of this method is cautioned to interpret the analyte concentrations in the extracts as a qualitative, not quantitative indication of the presence of those analytes at the concentrations measured. The heterogeneity and particle size distribution of the test samples may strongly influence the precision of this test method.

13.2 *Bias*—No information on the accuracy of this test method is known because suitable reference materials were not available for testing during the interlaboratory study. The user

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of this method is encouraged to employ accepted reference materials, if available, to determine the accuracy of this method as applied to a specific laboratory.

14. Keywords

14.1 column percolation; meteoric water mobility; mine rock

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APPENDIX C

Laboratory Data

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ANALYTICAL SUMMARY REPORT

September 10, 2009

Denison Mines (USA) Corp
1050 17th Ste 950
Denver, CO 80265

Workorder No.: C09080308 Quote ID: C3147 - Pandora Rock Samples

Project Name: Pandora Samples

Energy Laboratories, Inc. received the following 6 samples for Denison Mines (USA) Corp on 8/10/2009 for analysis.

Sample ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
C09080308-001	Pandora RK-1 Total Metals	07/23/09 10:00	08/10/09	Solid	Metals by ICP/ICPMS, Total Mercury, Total Percent Moisture Digestion, Total Metals CVAA Permanganate Digest
C09080308-002	Pandora RK-2 Total Metals	07/23/09 10:00	08/10/09	Solid	Same As Above
C09080308-003	Pandora RK-3 Total Metals	07/23/09 10:00	08/10/09	Solid	Same As Above
C09080308-004	DM-P RK-1	07/23/09 13:00	08/10/09	Solid	Metals by ICP/ICPMS, Dissolved Metals by ICP/ICPMS, Total Conductivity Mercury, Dissolved Mercury, Total Mercury Analysis Prep Oxygen, Dissolved Fluoride Hardness E300.0 Anions Nevada Leachate Procedure Nitrogen, Ammonia Nitrogen, Nitrite Nitrogen, Nitrate + Nitrite Nitrogen, Nitrate as N Oxidation Reduction Potential pH Metals Preparation by EPA 200.2 Gross Alpha, Gross Beta Solids, Total Dissolved
C09080308-005	DM-P RK-2	07/23/09 12:00	08/10/09	Solid	Same As Above
C09080308-006	DM-P RK-3	07/23/09 15:00	08/10/09	Solid	Same As Above

As appropriate, any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

If you have any questions regarding these tests results, please call.

Report Approved By: Stephanie D. Waldrop

Stephanie D. Waldrop
Reporting Supervisor

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-001
Client Sample ID: Pandora RK-1 Total Metals

Report Date: 09/10/09
Collection Date: 07/23/09 10:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
AGRONOMIC PROPERTIES							
Moisture	5.1	%		0.1		USDA26	08/11/09 14:19 / lbb
METALS - TOTAL							
Aluminum	1550	mg/kg-dry	D	0.7		SW6020	08/18/09 17:57 / sml
Antimony	ND	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Arsenic	25.0	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Barium	95.3	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Beryllium	ND	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Boron	6.4	mg/kg-dry		5.0		SW6010B	09/08/09 23:54 / cp
Cadmium	3.1	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Calcium	13100	mg/kg-dry		5.0		SW6010B	09/08/09 23:54 / cp
Chromium	3.3	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Cobalt	2.5	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Copper	8.3	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Iron	2550	mg/kg-dry	D	1		SW6020	08/18/09 17:57 / sml
Lead	159	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Lithium	ND	mg/kg-dry		10.0		SW6010B	09/08/09 23:54 / cp
Magnesium	2540	mg/kg-dry		5.0		SW6010B	09/08/09 23:54 / cp
Manganese	204	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Mercury	ND	mg/kg-dry		0.05		SW7471A	08/14/09 15:07 / jp
Molybdenum	29.7	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Nickel	2.8	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Phosphorus	147	mg/kg-dry		10.0		SW6010B	09/08/09 23:54 / cp
Potassium	941	mg/kg-dry		5.0		SW6010B	09/08/09 23:54 / cp
Selenium	22.6	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Silica	1200	mg/kg-dry		10.7		SW6020	08/18/09 17:57 / sml
Silver	0.7	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Sodium	21.5	mg/kg-dry	D	9.2		SW6010B	09/08/09 23:54 / cp
Strontium	27.2	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Thallium	ND	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Tin	1.2	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Titanium	29.5	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Uranium	149	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Vanadium	342	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml
Zinc	366	mg/kg-dry		0.5		SW6020	08/18/09 17:57 / sml

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-002
Client Sample ID: Pandora RK-2 Total Metals

Report Date: 09/10/09
Collection Date: 07/23/09 10:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
AGRONOMIC PROPERTIES							
Moisture	3.3	%		0.1		USDA26	08/11/09 14:20 / lbb
METALS - TOTAL							
Aluminum	1080	mg/kg-dry	D	0.8		SW6020	08/18/09 18:07 / sml
Antimony	ND	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Arsenic	7.5	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Barium	121	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Beryllium	ND	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Boron	ND	mg/kg-dry		5.0		SW6010B	09/09/09 00:02 / cp
Cadmium	0.6	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Calcium	13500	mg/kg-dry		5.0		SW6010B	09/09/09 00:02 / cp
Chromium	4.8	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Cobalt	1.8	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Copper	16.0	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Iron	1930	mg/kg-dry	D	1.1		SW6020	08/18/09 18:07 / sml
Lead	74.3	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Lithium	ND	mg/kg-dry		10.0		SW6010B	09/09/09 00:02 / cp
Magnesium	2680	mg/kg-dry		5.0		SW6010B	09/09/09 00:02 / cp
Manganese	204	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Mercury	ND	mg/kg-dry		0.05		SW7471A	08/14/09 15:13 / jp
Molybdenum	5.7	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Nickel	1.8	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Phosphorus	121	mg/kg-dry		10.0		SW6010B	09/09/09 00:02 / cp
Potassium	713	mg/kg-dry		5.0		SW6010B	09/09/09 00:02 / cp
Selenium	11.1	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Silica	1150	mg/kg-dry		10.7		SW6020	08/18/09 18:07 / sml
Silver	ND	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Sodium	ND	mg/kg-dry	D	10.0		SW6010B	09/09/09 00:02 / cp
Strontium	23.4	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Thallium	ND	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Tin	1	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Titanium	12.2	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Uranium	44.8	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Vanadium	187	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml
Zinc	65.1	mg/kg-dry		0.5		SW6020	08/18/09 18:07 / sml

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-003
Client Sample ID: Pandora RK-3 Total Metals

Report Date: 09/10/09
Collection Date: 07/23/09 10:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
AGRONOMIC PROPERTIES							
Moisture	1.3	%		0.1		USDA26	08/11/09 14:21 / lbb
METALS - TOTAL							
Aluminum	2470	mg/kg-dry	D	0.7		SW6020	08/18/09 18:12 / sml
Antimony	ND	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Arsenic	40.9	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Barium	114	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Beryllium	ND	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Boron	ND	mg/kg-dry		5.0		SW6010B	09/09/09 00:06 / cp
Cadmium	2.9	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Calcium	13600	mg/kg-dry		5.0		SW6010B	09/09/09 00:06 / cp
Chromium	3.4	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Cobalt	4.3	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Copper	54.2	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Iron	4790	mg/kg-dry	D	1.0		SW6020	08/18/09 18:12 / sml
Lead	395	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Lithium	ND	mg/kg-dry		10.0		SW6010B	09/09/09 00:06 / cp
Magnesium	3370	mg/kg-dry		5.0		SW6010B	09/09/09 00:06 / cp
Manganese	231	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Mercury	ND	mg/kg-dry		0.05		SW7471A	08/14/09 15:15 / jp
Molybdenum	27.5	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Nickel	3.4	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Phosphorus	174	mg/kg-dry		10.0		SW6010B	09/09/09 00:06 / cp
Potassium	1230	mg/kg-dry		5.0		SW6010B	09/09/09 00:06 / cp
Selenium	31.9	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Silica	1690	mg/kg-dry		10.7		SW6020	08/18/09 18:12 / sml
Silver	0.8	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Sodium	244	mg/kg-dry	D	9.7		SW6010B	09/09/09 00:06 / cp
Strontium	44.3	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Thallium	ND	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Tin	1	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Titanium	34.6	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Uranium	160	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Vanadium	443	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml
Zinc	187	mg/kg-dry		0.5		SW6020	08/18/09 18:12 / sml

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-004
Client Sample ID: DM-P RK-1

Report Date: 09/10/09
Collection Date: 07/23/09 13:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
MAJOR IONS - MWMP EXTRACTABLE							
Calcium	98	mg/L		1		E200.7	09/02/09 19:14 / cp
Chloride	6490	ug/L		1000		E300.0	08/27/09 00:39 / ljl
Fluoride	430	ug/L		100		A4500-F C	08/24/09 13:27 / dvg
Magnesium	67	mg/L		1		E200.7	09/02/09 19:14 / cp
Nitrogen, Ammonia as N	26900	ug/L	D	400		A4500-NH3 G	08/17/09 11:03 / jal
Nitrogen, Nitrate as N	103000	ug/L		50		E353.2	08/21/09 17:39 / sec
Nitrogen, Nitrate+Nitrite as N	104000	ug/L		50		E353.2	08/17/09 14:41 / jal
Nitrogen, Nitrite as N	663	ug/L		100		A4500-NO2 B	08/20/09 13:24 / jal
Sulfate	622000	ug/L		1000		E300.0	08/27/09 00:39 / ljl
NON-METALS - MWMP EXTRACTABLE							
Oxidation-Reduction Potential	234	mV				A2580 B	08/14/09 13:08 / lbb
PHYSICAL PROPERTIES - MWMP EXTRACTABLE							
Oxygen, Dissolved	6.3	mg/L		0.10		A4500-O G	08/14/09 15:45 / lbb
Conductivity	2020	umhos/cm		1		A2510 B	08/21/09 13:40 / dd
Hardness as CaCO3	523	mg/L		1		A2340 B	09/03/09 13:18 / tn
pH	7.09	s.u.		0.01		A4500-H B	08/21/09 13:40 / dd
Solids, Total Dissolved TDS @ 180 C	1380000	ug/L		10000		A2540 C	08/26/09 10:50 / dd
METALS - MWMP EXTRACTABLE							
Aluminum	ND	ug/L		100		E200.8	08/19/09 17:55 / sml
Antimony	6	ug/L		1		E200.8	08/19/09 17:55 / sml
Arsenic	201	ug/L		1		E200.8	08/19/09 17:55 / sml
Barium	54	ug/L		1		E200.8	08/19/09 17:55 / sml
Beryllium	ND	ug/L		1		E200.8	08/19/09 17:55 / sml
Boron	ND	ug/L		100		E200.7	09/02/09 19:14 / cp
Cadmium	ND	ug/L		1		E200.8	08/19/09 17:55 / sml
Chromium	ND	ug/L		1		E200.8	08/19/09 17:55 / sml
Cobalt	18	ug/L		1		E200.8	08/19/09 17:55 / sml
Copper	6	ug/L		1		E200.8	08/19/09 17:55 / sml
Iron	ND	ug/L		30		E200.8	08/19/09 17:55 / sml
Lead	ND	ug/L		1		E200.8	08/19/09 17:55 / sml
Lithium	104	ug/L		100		E200.7	09/02/09 19:14 / cp
Manganese	162	ug/L		1		E200.8	08/19/09 17:55 / sml
Mercury	ND	ug/L		1		E245.1	08/19/09 12:43 / jp
Molybdenum	688	ug/L		1		E200.8	08/19/09 17:55 / sml
Nickel	12	ug/L		1		E200.8	08/19/09 17:55 / sml
Selenium	673	ug/L		1		E200.8	08/19/09 17:55 / sml
Silver	ND	ug/L		1		E200.8	09/10/09 13:04 / sml
Thallium	1	ug/L		1		E200.8	08/19/09 17:55 / sml
Uranium	527	ug/L		1		E200.8	08/19/09 17:55 / sml
Vanadium	5400	ug/L		1		E200.8	08/19/09 17:55 / sml
Zinc	10	ug/L		1		E200.8	09/10/09 13:04 / sml

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-004
Client Sample ID: DM-P RK-1

Report Date: 09/10/09
Collection Date: 07/23/09 13:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS - MWMP EXTRACTABLE TOTAL RECOVERABLE							
Aluminum	626	ug/L		100		E200.8	08/19/09 18:00 / sml
Iron	185	ug/L		30		E200.8	08/19/09 18:00 / sml
Mercury	ND	ug/L		1		E245.1	08/19/09 12:37 / jp
RADIONUCLIDES - MWMP EXTRACTABLE							
Gross Alpha	1050	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Alpha precision (±)	26.7	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Alpha MDC	6.6	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta	238	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta precision (±)	6.0	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta MDC	5.0	pCi/L				E900.0	08/29/09 02:43 / cgr

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-005
Client Sample ID: DM-P RK-2

Report Date: 09/10/09
Collection Date: 07/23/09 12:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
MAJOR IONS - MWMP EXTRACTABLE							
Calcium	91	mg/L		1		E200.7	09/02/09 19:18 / cp
Chloride	23900	ug/L		1000		E300.0	08/27/09 00:54 / ljl
Fluoride	380	ug/L		100		A4500-F C	08/24/09 13:30 / dvg
Magnesium	50	mg/L		1		E200.7	09/02/09 19:18 / cp
Nitrogen, Ammonia as N	52500	ug/L	D	1000		A4500-NH3 G	08/17/09 11:05 / jal
Nitrogen, Nitrate as N	51700	ug/L		50		E353.2	08/21/09 17:39 / sec
Nitrogen, Nitrate+Nitrite as N	52500	ug/L		50		E353.2	08/17/09 14:44 / jal
Nitrogen, Nitrite as N	758	ug/L		100		A4500-NO2 B	08/20/09 13:24 / jal
Sulfate	509000	ug/L		1000		E300.0	08/27/09 00:54 / ljl
NON-METALS - MWMP EXTRACTABLE							
Oxidation-Reduction Potential	230	mV				A2580 B	08/14/09 13:08 / lbb
PHYSICAL PROPERTIES - MWMP EXTRACTABLE							
Oxygen, Dissolved	7.3	mg/L		0.10		A4500-O G	08/14/09 15:45 / lbb
Conductivity	1580	umhos/cm		1		A2510 B	08/21/09 13:41 / dd
Hardness as CaCO3	433	mg/L		1		A2340 B	09/03/09 13:18 / tn
pH	7.25	s.u.		0.01		A4500-H B	08/21/09 13:41 / dd
Solids, Total Dissolved TDS @ 180 C	1070000	ug/L		10000		A2540 C	08/26/09 10:51 / dd
METALS - MWMP EXTRACTABLE							
Aluminum	ND	ug/L		100		E200.8	08/19/09 18:04 / sml
Antimony	6	ug/L		1		E200.8	08/19/09 18:04 / sml
Arsenic	154	ug/L		1		E200.8	08/19/09 18:04 / sml
Barium	55	ug/L		1		E200.8	08/19/09 18:04 / sml
Beryllium	ND	ug/L		1		E200.8	08/19/09 18:04 / sml
Boron	ND	ug/L		100		E200.7	09/02/09 19:18 / cp
Cadmium	2	ug/L		1		E200.8	08/19/09 18:04 / sml
Chromium	ND	ug/L		1		E200.8	08/19/09 18:04 / sml
Cobalt	12	ug/L		1		E200.8	08/19/09 18:04 / sml
Copper	6	ug/L		1		E200.8	08/19/09 18:04 / sml
Iron	ND	ug/L		30		E200.8	08/19/09 18:04 / sml
Lead	ND	ug/L		1		E200.8	08/19/09 18:04 / sml
Lithium	ND	ug/L		100		E200.7	09/02/09 19:18 / cp
Manganese	141	ug/L		1		E200.8	08/19/09 18:04 / sml
Mercury	ND	ug/L		1		E245.1	08/19/09 12:45 / jp
Molybdenum	2440	ug/L		1		E200.8	08/19/09 18:04 / sml
Nickel	8	ug/L		1		E200.8	08/19/09 18:04 / sml
Selenium	769	ug/L		1		E200.8	08/19/09 18:04 / sml
Silver	ND	ug/L		1		E200.8	09/10/09 13:09 / sml
Thallium	1	ug/L		1		E200.8	08/19/09 18:04 / sml
Uranium	330	ug/L		1		E200.8	08/19/09 18:04 / sml
Vanadium	3110	ug/L		1		E200.8	08/19/09 18:04 / sml
Zinc	12	ug/L		1		E200.8	09/10/09 13:09 / sml

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix interference.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-005
Client Sample ID: DM-P RK-2

Report Date: 09/10/09
Collection Date: 07/23/09 12:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS - MWMP EXTRACTABLE TOTAL RECOVERABLE							
Aluminum	ND	ug/L		100		E200.8	08/19/09 18:09 / sml
Iron	ND	ug/L		30		E200.8	08/19/09 18:09 / sml
Mercury	ND	ug/L		1		E245.1	08/19/09 12:39 / jp
RADIONUCLIDES - MWMP EXTRACTABLE							
Gross Alpha	844	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Alpha precision (±)	21.2	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Alpha MDC	5.1	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta	181	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta precision (±)	4.6	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta MDC	4.0	pCi/L				E900.0	08/29/09 02:43 / cgr

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-006
Client Sample ID: DM-P RK-3

Report Date: 09/10/09
Collection Date: 07/23/09 15:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
MAJOR IONS - MWMP EXTRACTABLE							
Calcium	213	mg/L		1		E200.7	09/02/09 19:22 / cp
Chloride	31900	ug/L		1000		E300.0	08/27/09 01:09 / ljl
Fluoride	590	ug/L		100		A4500-F C	08/24/09 13:33 / dvg
Magnesium	100	mg/L		1		E200.7	09/02/09 19:22 / cp
Nitrogen, Ammonia as N	2370	ug/L		30		A4500-NH3 G	08/25/09 11:36 / jal
Nitrogen, Nitrate as N	104000	ug/L		50		E353.2	08/26/09 13:25 / sec
Nitrogen, Nitrate+Nitrite as N	105000	ug/L		50		E353.2	08/24/09 11:46 / jal
Nitrogen, Nitrite as N	1180	ug/L		100		A4500-NO2 B	08/20/09 13:25 / jal
Sulfate	774000	ug/L		1000		E300.0	08/27/09 01:09 / ljl
NON-METALS - MWMP EXTRACTABLE							
Oxidation-Reduction Potential	241	mV				A2580 B	08/17/09 12:30 / lbb
PHYSICAL PROPERTIES - MWMP EXTRACTABLE							
Oxygen, Dissolved	7.2	mg/L		0.10		A4500-O G	08/17/09 16:35 / lbb
Conductivity	2320	umhos/cm		1		A2510 B	08/21/09 13:43 / dd
Hardness as CaCO3	946	mg/L		1		A2340 B	09/03/09 13:18 / tn
pH	7.79	s.u.		0.01		A4500-H B	08/21/09 13:43 / dd
Solids, Total Dissolved TDS @ 180 C	1870000	ug/L		10000		A2540 C	08/26/09 10:51 / dd
METALS - MWMP EXTRACTABLE							
Aluminum	ND	ug/L		100		E200.8	08/21/09 22:02 / sml
Antimony	5	ug/L		1		E200.8	08/21/09 22:02 / sml
Arsenic	219	ug/L		1		E200.8	08/21/09 22:02 / sml
Barium	49	ug/L		1		E200.8	08/21/09 22:02 / sml
Beryllium	ND	ug/L		1		E200.8	08/21/09 22:02 / sml
Boron	ND	ug/L		100		E200.8	08/21/09 22:02 / sml
Cadmium	2	ug/L		1		E200.8	08/21/09 22:02 / sml
Chromium	ND	ug/L		1		E200.8	08/21/09 22:02 / sml
Cobalt	9	ug/L		1		E200.8	08/21/09 22:02 / sml
Copper	7	ug/L		1		E200.8	08/21/09 22:02 / sml
Iron	ND	ug/L		30		E200.8	08/21/09 22:02 / sml
Lead	ND	ug/L		1		E200.8	08/21/09 22:02 / sml
Lithium	100	ug/L		100		E200.7	09/02/09 19:22 / cp
Manganese	110	ug/L		1		E200.8	08/21/09 22:02 / sml
Mercury	ND	ug/L		1		E245.1	08/19/09 12:47 / jp
Molybdenum	2090	ug/L		1		E200.8	08/21/09 22:02 / sml
Nickel	8	ug/L		1		E200.8	08/21/09 22:02 / sml
Selenium	1210	ug/L		1		E200.8	08/21/09 22:02 / sml
Silver	ND	ug/L		1		E200.8	08/21/09 22:02 / sml
Thallium	ND	ug/L		1		E200.8	08/21/09 22:02 / sml
Uranium	356	ug/L		1		E200.8	08/21/09 22:02 / sml
Vanadium	3530	ug/L		1		E200.8	08/21/09 22:02 / sml
Zinc	14	ug/L		1		E200.8	08/21/09 22:02 / sml

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Denison Mines (USA) Corp
Project: Pandora Samples
Lab ID: C09080308-006
Client Sample ID: DM-P RK-3

Report Date: 09/10/09
Collection Date: 07/23/09 15:00
DateReceived: 08/10/09
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
METALS - MWMP EXTRACTABLE TOTAL RECOVERABLE							
Aluminum	ND	ug/L		100		E200.8	08/21/09 22:07 / sml
Iron	ND	ug/L		30		E200.8	08/21/09 22:07 / sml
Mercury	ND	ug/L		1		E245.1	08/19/09 12:41 / jp
RADIONUCLIDES - MWMP EXTRACTABLE							
Gross Alpha	634	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Alpha precision (±)	25.6	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Alpha MDC	9.7	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta	146	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta precision (±)	6.9	pCi/L				E900.0	08/29/09 02:43 / cgr
Gross Beta MDC	7.8	pCi/L				E900.0	08/29/09 02:43 / cgr

Report Definitions:
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QCL - Quality control limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A2510 B									Analytical Run: ORION555A_090821A	
Sample ID: ICV2_090821_2		Initial Calibration Verification Standard							08/21/09 12:43	
Conductivity		4960	umhos/cm	1.0	99	90	110			
Method: A2510 B									Batch: 090821_2_PH-W_555A-1	
Sample ID: MBLK1_090821_2		Method Blank				Run: ORION555A_090821A			08/21/09 12:40	
Conductivity		1	umhos/cm	0.2						
Sample ID: C09080308-006ADUP		Sample Duplicate				Run: ORION555A_090821A			08/21/09 13:45	
Conductivity		2320	umhos/cm	1.0				0.2	10	
Method: A2540 C									Batch: 090826_2_SLDS-TDS-W	
Sample ID: MBLK1_090826		Method Blank				Run: BAL-1_090826B			08/26/09 10:49	
Solids, Total Dissolved TDS @ 180 C		ND	mg/L	6						
Sample ID: LCS1_090826		Laboratory Control Sample				Run: BAL-1_090826B			08/26/09 10:50	
Solids, Total Dissolved TDS @ 180 C		1010	mg/L	10	101	90	110			
Sample ID: C09080701-001AMS		Sample Matrix Spike				Run: BAL-1_090826B			08/26/09 10:51	
Solids, Total Dissolved TDS @ 180 C		2360	mg/L	10	106	90	110			
Sample ID: C09080701-001AMSD		Sample Matrix Spike Duplicate				Run: BAL-1_090826B			08/26/09 10:52	
Solids, Total Dissolved TDS @ 180 C		2300	mg/L	10	102	90	110	2.7	10	
Method: A2580 B									Batch: R122355	
Sample ID: LCS		Laboratory Control Sample				Run: ANALYST_090814B			08/14/09 13:08	
Oxidation-Reduction Potential		233	mV		102	95.6	104.4			
Method: A2580 B									Batch: R122449	
Sample ID: LCS		Laboratory Control Sample				Run: ANALYST_090817C			08/17/09 00:00	
Oxidation-Reduction Potential		234	mV		103	95.6	104.4			
Method: A4500-F C									Batch: R122803	
Sample ID: MBLK		Method Blank				Run: MANTECH_090824A			08/24/09 13:16	
Fluoride		ND	mg/L	0.05						
Sample ID: LCS		Laboratory Control Sample				Run: MANTECH_090824A			08/24/09 13:19	
Fluoride		1.00	mg/L	0.10	100	90	110			
Sample ID: C09080620-001AMS		Sample Matrix Spike				Run: MANTECH_090824A			08/24/09 13:40	
Fluoride		1.28	mg/L	0.10	101	80	120			
Sample ID: C09080620-001AMSD		Sample Matrix Spike Duplicate				Run: MANTECH_090824A			08/24/09 13:47	
Fluoride		1.28	mg/L	0.10	101	80	120	0	10	

Qualifiers:

RL - Analyte reporting limit.
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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A4500-H B									Analytical Run: ORION555A_090821A	
Sample ID: ICV1_090821_2		Initial Calibration Verification Standard							08/21/09 12:41	
pH		6.83	s.u.	0.010	100	98	102			
Method: A4500-H B									Batch: 090821_2_PH-W_555A-1	
Sample ID: C09080308-006ADUP		Sample Duplicate				Run: ORION555A_090821A			08/21/09 13:45	
pH		7.79	s.u.	0.010				0	10	
Method: A4500-NH3 G									Batch: R122420	
Sample ID: MBLK-1		Method Blank				Run: TECHNICON_090817A			08/17/09 10:58	
Nitrogen, Ammonia as N		ND	mg/L	0.02						
Sample ID: LCS-2		Laboratory Control Sample				Run: TECHNICON_090817A			08/17/09 11:01	
Nitrogen, Ammonia as N		19.6	mg/L	0.20	98	80	120			
Sample ID: C09080308-004AMS		Sample Matrix Spike				Run: TECHNICON_090817A			08/17/09 11:07	
Nitrogen, Ammonia as N		31.9	mg/L	1.0	103	80	120			
Sample ID: C09080308-004AMSD		Sample Matrix Spike Duplicate				Run: TECHNICON_090817A			08/17/09 11:09	
Nitrogen, Ammonia as N		36.4	mg/L	1.0	99	80	120	13	20	
Method: A4500-NH3 G									Batch: R122875	
Sample ID: MBLK-1		Method Blank				Run: TECHNICON_090825A			08/25/09 10:53	
Nitrogen, Ammonia as N		ND	mg/L	0.02						
Sample ID: LCS-2		Laboratory Control Sample				Run: TECHNICON_090825A			08/25/09 10:55	
Nitrogen, Ammonia as N		19.8	mg/L	0.20	99	80	120			
Sample ID: C09080694-002EMS		Sample Matrix Spike				Run: TECHNICON_090825A			08/25/09 11:38	
Nitrogen, Ammonia as N		2.44	mg/L	0.050	100	80	120			
Sample ID: C09080694-002EMSD		Sample Matrix Spike Duplicate				Run: TECHNICON_090825A			08/25/09 11:40	
Nitrogen, Ammonia as N		2.36	mg/L	0.050	97	80	120	3.3	20	
Method: A4500-NO2 B									Batch: A2009-08-20_6_NO2_01	
Sample ID: MBLK-1		Method Blank				Run: HACH DR3000_090820B			08/20/09 13:14	
Nitrogen, Nitrite as N		ND	mg/L	0.003						
Sample ID: C09080601-007AMS		Sample Matrix Spike				Run: HACH DR3000_090820B			08/20/09 13:26	
Nitrogen, Nitrite as N		0.0498	mg/L	0.10	105	90	110			
Sample ID: C09080601-007AMSD		Sample Matrix Spike Duplicate				Run: HACH DR3000_090820B			08/20/09 13:26	
Nitrogen, Nitrite as N		0.0498	mg/L	0.10	105	90	110		10	

Qualifiers:

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MDC - Minimum detectable concentration
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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.7										Batch: R123258
Sample ID: MB-090902A	4	Method Blank				Run: ICP2-C_090902A				09/02/09 11:22
Boron		ND	mg/L	0.03						
Calcium		ND	mg/L	0.2						
Lithium		ND	mg/L	0.0002						
Magnesium		ND	mg/L	0.09						
Sample ID: LFB-090902A	4	Laboratory Fortified Blank				Run: ICP2-C_090902A				09/02/09 11:26
Boron		0.979	mg/L	0.10	98	85	115			
Calcium		49.2	mg/L	0.50	98	85	115			
Lithium		0.901	mg/L	0.10	90	85	115			
Magnesium		48.8	mg/L	0.50	98	85	115			
Sample ID: C09080556-001CMS2	4	Sample Matrix Spike				Run: ICP2-C_090902A				09/02/09 19:30
Boron		2.13	mg/L	0.10	104	70	130			
Calcium		180	mg/L	1.0	96	70	130			
Lithium		2.04	mg/L	0.10	100	70	130			
Magnesium		127	mg/L	1.0	98	70	130			
Sample ID: C09080556-001CMSD	4	Sample Matrix Spike Duplicate				Run: ICP2-C_090902A				09/02/09 19:34
Boron		2.16	mg/L	0.10	106	70	130	1.5	20	
Calcium		182	mg/L	1.0	99	70	130	1.2	20	
Lithium		2.04	mg/L	0.10	100	70	130	0.1	20	
Magnesium		126	mg/L	1.0	97	70	130	0.3	20	

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R122618
Sample ID: LRB	18	Method Blank				Run: ICPMS4-C_090819A				08/19/09 14:41
Aluminum		ND	mg/L	0.0004						
Antimony		ND	mg/L	0.0005						
Arsenic		ND	mg/L	5E-05						
Barium		ND	mg/L	4E-05						
Beryllium		ND	mg/L	6E-05						
Cadmium		ND	mg/L	4E-05						
Chromium		ND	mg/L	4E-05						
Cobalt		ND	mg/L	4E-05						
Copper		ND	mg/L	7E-05						
Iron		ND	mg/L	0.0006						
Lead		ND	mg/L	2E-05						
Manganese		ND	mg/L	3E-05						
Molybdenum		ND	mg/L	0.0001						
Nickel		ND	mg/L	6E-05						
Selenium		ND	mg/L	3E-05						
Thallium		ND	mg/L	3E-05						
Uranium		ND	mg/L	3E-05						
Vanadium		ND	mg/L	4E-05						
Sample ID: LFB	18	Laboratory Fortified Blank				Run: ICPMS4-C_090819A				08/19/09 14:46
Aluminum		0.0567	mg/L	0.0010	113	85	115			
Antimony		0.0501	mg/L	0.0010	100	85	115			
Arsenic		0.0522	mg/L	0.0010	104	85	115			
Barium		0.0511	mg/L	0.0010	102	85	115			
Beryllium		0.0508	mg/L	0.0010	102	85	115			
Cadmium		0.0514	mg/L	0.0010	103	85	115			
Chromium		0.0519	mg/L	0.0010	104	85	115			
Cobalt		0.0533	mg/L	0.0010	107	85	115			
Copper		0.0532	mg/L	0.0010	106	85	115			
Iron		1.31	mg/L	0.0010	105	85	115			
Lead		0.0515	mg/L	0.0010	103	85	115			
Manganese		0.0533	mg/L	0.0010	107	85	115			
Molybdenum		0.0507	mg/L	0.0010	101	85	115			
Nickel		0.0529	mg/L	0.0010	106	85	115			
Selenium		0.0539	mg/L	0.0010	108	85	115			
Thallium		0.0494	mg/L	0.0010	99	85	115			
Uranium		0.0501	mg/L	0.00030	100	85	115			
Vanadium		0.0515	mg/L	0.0010	103	85	115			
Sample ID: C09080308-005AMS4	18	Sample Matrix Spike				Run: ICPMS4-C_090819A				08/19/09 18:14
Aluminum		0.199	mg/L	0.10	253	70	130			S
Antimony		0.0578	mg/L	0.050	104	70	130			
Arsenic		0.204	mg/L	0.0010	94	70	130			
Barium		0.108	mg/L	0.10	103	70	130			
Beryllium		0.0459	mg/L	0.010	92	70	130			

Qualifiers:

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8									Batch: R122618	
Sample ID: C09080308-005AMS4	18	Sample Matrix Spike				Run: ICPMS4-C_090819A			08/19/09 18:14	
Cadmium		0.0509	mg/L	0.010	98	70	130			
Chromium		0.0495	mg/L	0.0010	98	70	130			
Cobalt		0.0650	mg/L	0.010	104	70	130			
Copper		0.0532	mg/L	0.010	95	70	130			
Iron		2.66	mg/L	0.030	211	70	130			S
Lead		0.0532	mg/L	0.050	105	70	130			
Manganese		0.196	mg/L	0.010	98	70	130			
Molybdenum		2.55	mg/L	0.10		70	130			A
Nickel		0.0558	mg/L	0.050	96	70	130			
Selenium		0.795	mg/L	0.0010		70	130			A
Thallium		0.0517	mg/L	0.0010	101	70	130			
Uranium		0.391	mg/L	0.00030		70	130			A
Vanadium		3.25	mg/L	0.10		70	130			A
Sample ID: C09080308-005AMSD	18	Sample Matrix Spike Duplicate				Run: ICPMS4-C_090819A			08/19/09 18:19	
Aluminum		0.177	mg/L	0.10	210	70	130	12	20	S
Antimony		0.0578	mg/L	0.050	104	70	130	0.1	20	
Arsenic		0.202	mg/L	0.0010	90	70	130	1	20	
Barium		0.108	mg/L	0.10	102	70	130	0.4	20	
Beryllium		0.0473	mg/L	0.010	95	70	130	2.9	20	
Cadmium		0.0508	mg/L	0.010	97	70	130	0.2	20	
Chromium		0.0493	mg/L	0.0010	98	70	130	0.4	20	
Cobalt		0.0651	mg/L	0.010	105	70	130	0.2	20	
Copper		0.0533	mg/L	0.010	95	70	130	0.2	20	
Iron		2.68	mg/L	0.030	213	70	130	0.9	20	S
Lead		0.0533	mg/L	0.050	105	70	130	0.2	20	
Manganese		0.196	mg/L	0.010	99	70	130	0.1	20	
Molybdenum		2.53	mg/L	0.10		70	130	0.7	20	A
Nickel		0.0556	mg/L	0.050	95	70	130	0.4	20	
Selenium		0.791	mg/L	0.0010		70	130	0.5	20	A
Thallium		0.0520	mg/L	0.0010	102	70	130	0.5	20	
Uranium		0.393	mg/L	0.00030		70	130	0.6	20	A
Vanadium		3.22	mg/L	0.10		70	130	0.8	20	A

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MDC - Minimum detectable concentration

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R122732
Sample ID: LRB	21	Method Blank				Run: ICPMS4-C_090821B				08/21/09 17:33
Aluminum		ND	mg/L	0.0004						
Antimony		0.0006	mg/L	0.0006						
Arsenic		ND	mg/L	5E-05						
Barium		ND	mg/L	4E-05						
Beryllium		ND	mg/L	6E-05						
Boron		ND	mg/L	0.0004						
Cadmium		ND	mg/L	4E-05						
Chromium		ND	mg/L	4E-05						
Cobalt		ND	mg/L	4E-05						
Copper		ND	mg/L	7E-05						
Iron		ND	mg/L	0.0006						
Lead		ND	mg/L	2E-05						
Manganese		ND	mg/L	3E-05						
Molybdenum		ND	mg/L	0.0001						
Nickel		ND	mg/L	6E-05						
Selenium		4E-05	mg/L	3E-05						
Silver		0.0001	mg/L	4E-05						
Thallium		ND	mg/L	3E-05						
Uranium		ND	mg/L	3E-05						
Vanadium		ND	mg/L	4E-05						
Zinc		ND	mg/L	0.0002						
Sample ID: LFB	21	Laboratory Fortified Blank				Run: ICPMS4-C_090821B				08/21/09 17:38
Aluminum		0.0537	mg/L	0.0010	107	85	115			
Antimony		0.0517	mg/L	0.0010	102	85	115			
Arsenic		0.0520	mg/L	0.0010	104	85	115			
Barium		0.0520	mg/L	0.0010	104	85	115			
Beryllium		0.0520	mg/L	0.0010	104	85	115			
Boron		0.0460	mg/L	0.0010	92	85	115			
Cadmium		0.0521	mg/L	0.0010	104	85	115			
Chromium		0.0515	mg/L	0.0010	103	85	115			
Cobalt		0.0506	mg/L	0.0010	101	85	115			
Copper		0.0523	mg/L	0.0010	105	85	115			
Iron		1.27	mg/L	0.0010	102	85	115			
Lead		0.0515	mg/L	0.0010	103	85	115			
Manganese		0.0507	mg/L	0.0010	101	85	115			
Molybdenum		0.0520	mg/L	0.0010	104	85	115			
Nickel		0.0523	mg/L	0.0010	105	85	115			
Selenium		0.0514	mg/L	0.0010	103	85	115			
Silver		0.0206	mg/L	0.0010	102	85	115			
Thallium		0.0514	mg/L	0.0010	103	85	115			
Uranium		0.0486	mg/L	0.00030	97	85	115			
Vanadium		0.0515	mg/L	0.0010	103	85	115			
Zinc		0.0555	mg/L	0.0010	111	85	115			

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R122732
Sample ID: C09080308-006AMS4	21	Sample Matrix Spike				Run: ICPMS4-C_090821B			08/21/09 22:12	
Aluminum		0.128	mg/L	0.10	168	70	130			S
Antimony		0.0600	mg/L	0.050	110	70	130			
Arsenic		0.270	mg/L	0.0010		70	130			A
Barium		0.100	mg/L	0.0010	102	70	130			
Beryllium		0.0496	mg/L	0.010	99	70	130			
Boron		0.137	mg/L	0.10	111	70	130			
Cadmium		0.0527	mg/L	0.010	101	70	130			
Chromium		0.0532	mg/L	0.050	106	70	130			
Cobalt		0.0619	mg/L	0.010	105	70	130			
Copper		0.0596	mg/L	0.010	103	70	130			
Iron		1.28	mg/L	0.030	101	70	130			
Lead		0.0538	mg/L	0.050	104	70	130			
Manganese		0.162	mg/L	0.010	100	70	130			
Molybdenum		2.18	mg/L	0.10		70	130			A
Nickel		0.0602	mg/L	0.050	104	70	130			
Selenium		1.23	mg/L	0.0010		70	130			A
Silver		0.0161	mg/L	0.010	80	70	130			
Thallium		0.0525	mg/L	0.0010	104	70	130			
Uranium		0.404	mg/L	0.00030		70	130			A
Vanadium		3.61	mg/L	0.10		70	130			A
Zinc		0.0594	mg/L	0.010	100	70	130			
Sample ID: C09080308-006AMSD	21	Sample Matrix Spike Duplicate				Run: ICPMS4-C_090821B			08/21/09 22:17	
Aluminum		0.125	mg/L	0.10	161	70	130	2.5	20	S
Antimony		0.0592	mg/L	0.050	108	70	130	1.3	20	
Arsenic		0.269	mg/L	0.0010		70	130	0.4	20	A
Barium		0.0993	mg/L	0.0010	101	70	130	0.9	20	
Beryllium		0.0499	mg/L	0.010	100	70	130	0.6	20	
Boron		0.137	mg/L	0.10	110	70	130	0.1	20	
Cadmium		0.0515	mg/L	0.010	99	70	130	2.4	20	
Chromium		0.0524	mg/L	0.050	104	70	130	1.5	20	
Cobalt		0.0582	mg/L	0.010	97	70	130	6.2	20	
Copper		0.0590	mg/L	0.010	102	70	130	0.9	20	
Iron		1.31	mg/L	0.030	103	70	130	2.8	20	
Lead		0.0528	mg/L	0.050	102	70	130	1.8	20	
Manganese		0.161	mg/L	0.010	98	70	130	0.6	20	
Molybdenum		2.15	mg/L	0.10		70	130	1.5	20	A
Nickel		0.0593	mg/L	0.050	102	70	130	1.5	20	
Selenium		1.26	mg/L	0.0010		70	130	2.3	20	A
Silver		0.0151	mg/L	0.010	75	70	130	6.2	20	
Thallium		0.0515	mg/L	0.0010	102	70	130	2	20	
Uranium		0.402	mg/L	0.00030		70	130	0.5	20	A
Vanadium		3.59	mg/L	0.10		70	130	0.4	20	A
Zinc		0.0585	mg/L	0.010	98	70	130	1.6	20	

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MDC - Minimum detectable concentration

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E200.8										Batch: R123554
Sample ID: LRB	2	Method Blank				Run: ICPMS4-C_090910A				09/10/09 12:49
Silver		ND	mg/L	4E-05						
Zinc		0.0002	mg/L	0.0002						
Sample ID: LFB	2	Laboratory Fortified Blank				Run: ICPMS4-C_090910A				09/10/09 12:54
Silver		0.0210	mg/L	0.0010	105	85	115			
Zinc		0.0548	mg/L	0.0010	109	85	115			
Sample ID: C09090354-005BMS4	2	Sample Matrix Spike				Run: ICPMS4-C_090910A				09/10/09 13:19
Silver		0.0150	mg/L	0.010	75	70	130			
Zinc		0.0594	mg/L	0.010	103	70	130			
Sample ID: C09090354-005BMSD	2	Sample Matrix Spike Duplicate				Run: ICPMS4-C_090910A				09/10/09 13:24
Silver		0.0167	mg/L	0.010	84	70	130	11	20	
Zinc		0.0593	mg/L	0.010	103	70	130	0.1	20	
Method: E245.1										Analytical Run: CVAA_C203_090819A
Sample ID: ICV		Initial Calibration Verification Standard								08/19/09 12:23
Mercury		0.00488	mg/L	0.0010	98	90	110			
Sample ID: CCV		Continuing Calibration Verification Standard								08/19/09 12:25
Mercury		0.00503	mg/L	0.0010	101	90	110			
Method: E245.1										Batch: 23442
Sample ID: MB-23442		Method Blank				Run: CVAA_C203_090819A				08/19/09 12:29
Mercury		ND	mg/L							
Sample ID: LCS-23442		Laboratory Control Sample				Run: CVAA_C203_090819A				08/19/09 12:35
Mercury		0.00486	mg/L	0.00010	97	90	110			
Sample ID: C09080601-006DMS		Sample Matrix Spike				Run: CVAA_C203_090819A				08/19/09 12:51
Mercury		0.0556	mg/L	0.00020	111	85	115			
Sample ID: C09080601-006DMSD		Sample Matrix Spike Duplicate				Run: CVAA_C203_090819A				08/19/09 13:01
Mercury		0.0557	mg/L	0.00020	111	85	115	0.1	10	

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E300.0									Batch: R122977	
Sample ID: LCS	2	Laboratory Control Sample				Run: IC1-C_090826B			08/26/09 23:52	
Chloride		9.30	mg/L	1.0	93	90	110			
Sulfate		37.3	mg/L	1.0	93	90	110			
Sample ID: MBLK	2	Method Blank				Run: IC1-C_090826B			08/27/09 00:08	
Chloride		ND	mg/L	0.01						
Sulfate		ND	mg/L	0.06						
Sample ID: C09080664-004AMS	2	Sample Matrix Spike				Run: IC1-C_090826B			08/27/09 01:40	
Chloride		146	mg/L	1.0	102	90	110			
Sulfate		1590	mg/L	1.0	78	90	110			S
- Matrix spike recoveries outside the acceptance range are considered matrix-related.										
Sample ID: C09080664-004AMSD	2	Sample Matrix Spike Duplicate				Run: IC1-C_090826B			08/27/09 01:56	
Chloride		148	mg/L	1.0	103	90	110	0.8	20	
Sulfate		1580	mg/L	1.0	78	90	110	0.2	20	S
- Matrix spike recoveries outside the acceptance range are considered matrix-related.										
Method: E353.2									Batch: R122436	
Sample ID: MBLK-1		Method Blank				Run: TECHNICON_090817B			08/17/09 14:16	
Nitrogen, Nitrate+Nitrite as N		ND	mg/L	0.03						
Sample ID: LCS-2		Laboratory Control Sample				Run: TECHNICON_090817B			08/17/09 14:19	
Nitrogen, Nitrate+Nitrite as N		2.56	mg/L	0.10	102	90	110			
Sample ID: C09080409-002CMS		Sample Matrix Spike				Run: TECHNICON_090817B			08/17/09 14:34	
Nitrogen, Nitrate+Nitrite as N		2.13	mg/L	0.10	106	90	110			
Sample ID: C09080409-002CMSD		Sample Matrix Spike Duplicate				Run: TECHNICON_090817B			08/17/09 14:36	
Nitrogen, Nitrate+Nitrite as N		2.11	mg/L	0.10	105	90	110	0.9	10	

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E900.0										Batch: GrAB-0730
Sample ID: MB-GrAB-0730	6	Method Blank				Run: G5000W_090824A				08/29/09 02:43
Gross Alpha		-0.2	pCi/L							U
Gross Alpha precision (±)		0.7	pCi/L							
Gross Alpha MDC		0.8	pCi/L							
Gross Beta		-1	pCi/L							U
Gross Beta precision (±)		1	pCi/L							
Gross Beta MDC		2	pCi/L							
Sample ID: UNAT-GrAB-0730		Laboratory Control Sample				Run: G5000W_090824A				08/29/09 02:43
Gross Alpha		100	pCi/L		101	70	130			
Sample ID: Cs137-GrAB-0730		Laboratory Control Sample				Run: G5000W_090824A				08/29/09 02:43
Gross Beta		85	pCi/L		94	70	130			
Sample ID: C09080555-002AMS		Sample Matrix Spike				Run: G5000W_090824A				08/31/09 09:28
Gross Alpha		157	pCi/L		153	70	130			S
- Spike response is outside of the acceptance range for this analysis. Since the LCS and the RPD for the MS MSD pair are acceptable, the response is considered to be matrix related. The batch is approved.										
Sample ID: C09080555-002AMSD		Sample Matrix Spike Duplicate				Run: G5000W_090824A				08/31/09 09:28
Gross Alpha		150	pCi/L		145	70	130	4.7	19.3	S
Sample ID: C09080555-002AMS		Sample Matrix Spike				Run: G5000W_090824A				08/31/09 09:28
Gross Beta		97.2pCi/L			105	70	130			
Sample ID: C09080555-002AMSD		Sample Matrix Spike Duplicate				Run: G5000W_090824A				08/31/09 09:28
Gross Beta		89.4pCi/L			96	70	130	8.4	16.2	

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QA/QC Summary Report

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Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B										Batch: 23431
Sample ID: MB-23431	7	Method Blank				Run: ICP2-C_090908A				09/08/09 23:45
Boron		1	mg/kg	0.04						
Calcium		5	mg/kg	0.2						
Lithium		0.02	mg/kg	0.007						
Magnesium		ND	mg/kg	0.1						
Phosphorus		0.9	mg/kg	0.01						
Potassium		0.6	mg/kg	0.2						
Sodium		30	mg/kg	1.0						
Sample ID: LCS3-23431	7	Laboratory Control Sample				Run: ICP2-C_090908A				09/08/09 23:49
Boron		110	mg/kg	5.0	88	62.6	138			
Calcium		3900	mg/kg	5.0	88	67.3	137			
Lithium		8.2	mg/kg	5.0	118	0	254			
Magnesium		2600	mg/kg	5.0	92	74.1	135			
Phosphorus		750	mg/kg	5.0	86	0	200			
Potassium		2900	mg/kg	5.0	95	72.7	131			
Sodium		440	mg/kg	5.0	80	32.7	176			
Sample ID: C09080568-009AMS3	7	Sample Matrix Spike				Run: ICP2-C_090908A				09/09/09 00:14
Boron		29	mg/kg-dry	5.0	65	75	125			S
Calcium		3700	mg/kg-dry	5.0	89	75	125			
Lithium		37	mg/kg-dry	5.0	111	75	125			
Magnesium		4700	mg/kg-dry	5.0	94	75	125			
Phosphorus		610	mg/kg-dry	5.0	86	75	125			
Potassium		3600	mg/kg-dry	5.0	91	75	125			
Sodium		1300	mg/kg-dry	5.0	92	75	125			
Sample ID: C09080568-009AMSD	7	Sample Matrix Spike Duplicate				Run: ICP2-C_090908A				09/09/09 00:18
Boron		34	mg/kg-dry	5.0	87	75	125	17	20	
Calcium		3600	mg/kg-dry	5.0	82	75	125	2.3	20	
Lithium		36	mg/kg-dry	5.0	107	75	125	2.7	20	
Magnesium		4500	mg/kg-dry	5.0	82	75	125	3.3	20	
Phosphorus		600	mg/kg-dry	5.0	84	75	125	1	20	
Potassium		3500	mg/kg-dry	5.0	89	75	125	0.7	20	
Sodium		1300	mg/kg-dry	5.0	93	75	125	1.4	20	

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S - Spike recovery outside of advisory limits.

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020										Batch: 23431
Sample ID: MB-23431	24	Method Blank				Run: ICPMS4-C_090818A				08/18/09 17:41
Aluminum		0.3	mg/kg	0.07						
Antimony		0.06	mg/kg	0.002						
Arsenic		0.2	mg/kg	0.0004						
Barium		0.02	mg/kg	0.003						
Beryllium		0.0003	mg/kg	0.0002						
Cadmium		0.001	mg/kg	0.0001						
Chromium		0.2	mg/kg	0.002						
Cobalt		0.002	mg/kg	0.0001						
Copper		0.2	mg/kg	0.0007						
Iron		2	mg/kg	0.1						
Lead		0.007	mg/kg	0.0001						
Manganese		0.09	mg/kg	0.002						
Molybdenum		0.02	mg/kg	0.0002						
Nickel		0.03	mg/kg	0.002						
Selenium		0.03	mg/kg	0.0001						
Silicon		1	mg/kg	0.2						
Silver		0.02	mg/kg	0.02						
Strontium		0.01	mg/kg	0.004						
Thallium		ND	mg/kg	0.0002						
Tin		1	mg/kg	0.002						
Titanium		0.1	mg/kg	0.002						
Uranium		0.003	mg/kg	0.0001						
Vanadium		1	mg/kg	0.0005						
Zinc		0.4	mg/kg	0.003						
Sample ID: LCS3-23431	24	Laboratory Control Sample				Run: ICPMS4-C_090818A				08/18/09 17:47
Aluminum		6700	mg/kg	1.9	91	88	120			
Antimony		76	mg/kg	0.50	119	68.2	139			
Arsenic		190	mg/kg	0.50	99	89.2	117			
Barium		420	mg/kg	0.50	102	74.1	131			
Beryllium		130	mg/kg	0.50	103	79.2	126			
Cadmium		62	mg/kg	0.50	99	77.9	128			
Chromium		130	mg/kg	0.50	99	90	116			
Cobalt		140	mg/kg	0.50	98	83.8	122			
Copper		89	mg/kg	0.50	101	87.7	119			
Iron		14000	mg/kg	2.7	98	86.5	120			
Lead		140	mg/kg	0.50	100	80.4	125			
Manganese		280	mg/kg	0.50	97	82.3	124			
Molybdenum		140	mg/kg	0.50	99	82	124			
Nickel		180	mg/kg	0.50	99	89.8	116			
Selenium		120	mg/kg	0.50	94	83.1	124			
Silicon		1000	mg/kg	5.2	124	66.2	140			
Silver		74	mg/kg	0.50	99	69.3	136			
Strontium		120	mg/kg	0.50	97	81.9	124			

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration

ND - Not detected at the reporting limit.

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020										Batch: 23431
Sample ID: LCS3-23431	24	Laboratory Control Sample				Run: ICPMS4-C_090818A				08/18/09 17:47
Thallium		120	mg/kg	0.50	105	71.3	133			
Tin		160	mg/kg	0.50	96	77.7	128			
Titanium		300	mg/kg	0.50	93	92.8	115			
Uranium		110	mg/kg	0.50	126	87.4	173			
Vanadium		87	mg/kg	0.50	108	66.4	138			
Zinc		190	mg/kg	0.50	99	86.4	118			
Sample ID: C09080568-009AMS3	19	Sample Matrix Spike				Run: ICPMS4-C_090818A				08/18/09 19:23
Antimony		11	mg/kg-dry	0.50	45	75	125			S
Arsenic		37	mg/kg-dry	0.50	92	75	125			
Barium		190	mg/kg-dry	0.50		75	125			A
Cadmium		14	mg/kg-dry	0.50	109	75	125			
Chromium		49	mg/kg-dry	0.50	106	75	125			
Cobalt		37	mg/kg-dry	0.50	116	75	125			
Copper		35	mg/kg-dry	0.50	101	75	125			
Iron		21000	mg/kg-dry	1.1		75	125			A
Lead		39	mg/kg-dry	0.50	108	75	125			
Molybdenum		27	mg/kg-dry	0.50	102	75	125			
Nickel		43	mg/kg-dry	0.50	101	75	125			
Selenium		24	mg/kg-dry	0.50	92	75	125			
Silicon		720	mg/kg-dry	5.0	-20	75	125			S
Silver		14	mg/kg-dry	0.50	111	75	125			
Thallium		27	mg/kg-dry	0.50	105	75	125			
Tin		29	mg/kg-dry	0.50	110	75	125			
Titanium		140	mg/kg-dry	0.50		75	125			A
Vanadium		67	mg/kg-dry	0.50	106	75	125			
Zinc		75	mg/kg-dry	0.50	89	75	125			
Sample ID: C09080568-009AMSD	19	Sample Matrix Spike Duplicate				Run: ICPMS4-C_090818A				08/18/09 19:28
Antimony		12	mg/kg-dry	0.50	47	75	125	3.9	20	S
Arsenic		39	mg/kg-dry	0.50	100	75	125	5.2	20	
Barium		190	mg/kg-dry	0.50		75	125	2.1	20	A
Cadmium		15	mg/kg-dry	0.50	113	75	125	3.2	20	
Chromium		50	mg/kg-dry	0.50	110	75	125	1.8	20	
Cobalt		38	mg/kg-dry	0.50	120	75	125	3.1	20	
Copper		37	mg/kg-dry	0.50	108	75	125	5	20	
Iron		20000	mg/kg-dry	1.1		75	125	2.9	20	A
Lead		41	mg/kg-dry	0.50	113	75	125	3.2	20	
Molybdenum		27	mg/kg-dry	0.50	104	75	125	1.8	20	
Nickel		45	mg/kg-dry	0.50	106	75	125	3.3	20	
Selenium		24	mg/kg-dry	0.50	93	75	125	1.8	20	
Silicon		670	mg/kg-dry	5.0	-41	75	125	7.6	20	S
Silver		14	mg/kg-dry	0.50	115	75	125	3.7	20	
Thallium		28	mg/kg-dry	0.50	109	75	125	3.6	20	
Tin		30	mg/kg-dry	0.50	114	75	125	3.7	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

MDC - Minimum detectable concentration

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QA/QC Summary Report

Client: Denison Mines (USA) Corp
Project: Pandora Samples

Report Date: 09/10/09
Work Order: C09080308

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020										Batch: 23431
Sample ID: C09080568-009AMSD	19	Sample Matrix Spike Duplicate				Run: ICPMS4-C_090818A			08/18/09 19:28	
Titanium		130	mg/kg-dry	0.50		75	125	1.3	20	A
Vanadium		68	mg/kg-dry	0.50	107	75	125	0.4	20	
Zinc		77	mg/kg-dry	0.50	99	75	125	3.1	20	
Method: SW7471A										Batch: 23396
Sample ID: MB-23396		Method Blank				Run: CVAA_C203_090814A			08/14/09 15:00	
Mercury		ND	mg/kg	0.003						
Sample ID: LCS1-23396		Laboratory Control Sample				Run: CVAA_C203_090814A			08/14/09 15:05	
Mercury		5.5	mg/kg	0.050	108	71	127			
Sample ID: C09080308-001AMS		Sample Matrix Spike				Run: CVAA_C203_090814A			08/14/09 15:09	
Mercury		0.94	mg/kg-dry	0.050	104	80	120			
Sample ID: C09080308-001AMSD		Sample Matrix Spike Duplicate				Run: CVAA_C203_090814A			08/14/09 15:11	
Mercury		0.97	mg/kg-dry	0.050	108	80	120	3	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

MDC - Minimum detectable concentration

ENERGY LABORATORIES

Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT, provide as much information as possible. Refer to corresponding notes on reverse side.

Company Name: Denison Mines	Project Name, PWS #, Permit #, Etc.: Pandora Soil Samples
Report Mail Address: 1050 17th St Suite 950 Denver Colo	Contact Name, Phone, Fax, E-mail: Christy Woodward 303 389 4136 / Sampler Name if other than Contact: Danny Flannery
Invoice Address: "	Invoice Contact & Phone #: " / Purchase Order #: / ELI Quote #: See Keri Shroeder

Report Required For: POTW/WWTP ☐ DW ☐ Other _____

Special Report Formats - ELI must be notified prior to sample submittal for the following:

NELAC ☐ A2LA ☐ Level IV ☐

Other _____

EDD/EDT ☐ Format _____

Notify ELI prior to RUSH sample submittal for additional charges and scheduling

Shipped by: Drop Box

Cooler ID(s): 3 Buckets

Receipt Temp: N/A °C

Custody Seal Intact: Y N

Signature Match: Y N

	SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)	Collection Date	Collection Time	MATRIX (Number of Containers; Sample Type: A W S V B O; Air Water Soils/Solids Vegetation Bioassay Other)	ANALYSIS REQUESTED	SEE ATTACHED	Normal Turnaround (TAT)	RUSH Turnaround (TAT)	Comments:	LABORATORY USE ONLY Lab ID
1	Pandora rock Samples	7-23-9	1000						C09080308	
2	DMP RK-2	7239	1200							
3	DMP RK-1	7239	1300							
4	DMP Soil	7239	1400						Forwarded on	
5	DMP RK 3	723 9	1500						to CSU for soils	
6									testing on 8-10-09	
7									KLS	
8										
9										
10										

Custody Record MUST be Signed

Relinquished by (print):	Date/Time:	Signature:	Received by (print):	Date/Time:	Signature:
Danny Flannery	7-9-09				
Relinquished by (print):	Date/Time:	Signature:	Received by (print): Andrew Larsen	Date/Time: 8/10/09 9:00	Signature:

Sample Disposal: Return to client: _____ Lab Disposal: _____

LABORATORY USE ONLY

Sample Type: _____ # of fractions _____

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.

Visit our web site at *www.energylab.com* for additional information, downloadable fee schedule, forms, & links.

Energy Laboratories Inc
Workorder Receipt Checklist

Denison Mines (USA) Corp

C09080308

Login completed by: Kimberly Humiston

Date and Time Received: 8/10/2009 9:00 AM

Reviewed by:

Received by: al

Reviewed Date:

Carrier name: Drop Box

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature:	N/A°C		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Contact and Corrective Action Comments:

None

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Toll Free 888.235.0515 • 307.235.0515 • Fax 307.234.1639 • casper@energylab.com • www.energylab.com

CLIENT: Denison Mines (USA) Corp
Project: Pandora Samples
Sample Delivery Group: C09080308

Date: *10-Sep-09*

CASE NARRATIVE

ORIGINAL SAMPLE SUBMITTAL(S)
All original sample submittals have been returned with the data package.

SAMPLE TEMPERATURE COMPLIANCE: 4°C (±2°C)
Temperature of samples received may not be considered properly preserved by accepted standards. Samples that are hand delivered immediately after collection shall be considered acceptable if there is evidence that the chilling process has begun.

GROSS ALPHA ANALYSIS
Method 900.0 for gross alpha and gross beta is intended as a drinking water method for low TDS waters. Data provided by this method for non potable waters should be viewed as inconsistent.

RADON IN AIR ANALYSIS
The desired exposure time is 48 hours (2 days). The time delay in returning the canister to the laboratory for processing should be as short as possible to avoid excessive decay. Maximum recommended delay between end of exposure to beginning of counting should not exceed 8 days.

SOIL/SOLID SAMPLES
All samples reported on an as received basis unless otherwise indicated.

ATRAZINE, SIMAZINE AND PCB ANALYSIS
Data for PCBs, Atrazine and Simazine are reported from EPA 525.2. PCB data reported by ELI reflects the results for seven individual Aroclors. When the results for all seven are ND (not detected), the sample meets EPA compliance criteria for PCB monitoring.

SUBCONTRACTING ANALYSIS
Subcontracting of sample analyses to an outside laboratory may be required. If so, ENERGY LABORATORIES will utilize its branch laboratories or qualified contract laboratories for this service. Any such laboratories will be indicated within the Laboratory Analytical Report.

BRANCH LABORATORY LOCATIONS
eli-b - Energy Laboratories, Inc. - Billings, MT
eli-g - Energy Laboratories, Inc. - Gillette, WY
eli-h - Energy Laboratories, Inc. - Helena, MT
eli-r - Energy Laboratories, Inc. - Rapid City, SD
eli-t - Energy Laboratories, Inc. - College Station, TX

CERTIFICATIONS:
USEPA: WY00002, Radiochemical WY00937; FL-DOH NELAC: E87641, Radiochemical E871017; California: 02118CA; Oregon: WY200001; Utah: 3072350515; Virginia: 00057; Washington: C1903

ISO 17025 DISCLAIMER:
The results of this Analytical Report relate only to the items submitted for analysis.

ENERGY LABORATORIES, INC. - CASPER,WY certifies that certain method selections contained in this report meet requirements as set forth by the above accrediting authorities. Some results requested by the client may not be covered under these certifications. All analysis data to be submitted for regulatory enforcement should be certified in the sample state of origin. Please verify ELI's certification coverage by visiting www.energylab.com

ELI appreciates the opportunity to provide you with this analytical service. For additional information and services visit our web page www.energylab.com.

THIS IS THE FINAL PAGE OF THE LABORATORY ANALYTICAL REPORT

APPENDIX D

UNSAT-H Model Simulations

Calculation Brief Title:

Estimation of Percolation through Mine Rock Stockpiles Using UNSAT-H

1.0 Purpose/Objective

The purpose of this calculation is to estimate percolation through the Pandora Mine development rock area using UNSAT-H (Fayer 2000). UNSAT-H is a fortran-based model that is used to simulate the one-dimensional flow of water, vapor, and heat in soils. The code addresses the processes of precipitation, evaporation, plant transpiration, storage, and deep drainage.

2.0 Procedure

- Estimate physical and hydrological characteristics of development rock using data from a similar rock pile located at a Denison Mines operation in Colorado.
- Compile climate data from locations as close as possible to the site.
- Estimate percolation through development rock areas using UNSAT-H.

3.0 References/Data Sources

Advanced Terra Testing (ATT), 2009, *Laboratory data for soil water characteristic curve, saturated hydraulic conductivity, grain size analyses, and moisture content*. These data were developed from samples collected at the West Sunday Mine in August, 2009.

Benson, C., 2006, *An Introduction to Water Balance Modeling*, in: Benson, C., Albright, B., Rock, S., Valceschini, R., Waugh, J., Alternative Covers for Landfills, Waste Repositories, and Mine Wastes Workshop, November.

Fala, O., Molson, J., Aubertin, M., Bussiere, B, 2005, *Numerical Modeling of Flow and Capilary Barrier Effects in Unsaturated Waste Rock Piles*, Mine Water and the Environment, Vol. 24.

Fayer, M.J., 2000, *UNSAT-H Version 3.0: Unsaturated Soil Water and Heat Flow Model Theory, User Manual, and Examples*.

Ford, R.C., Pierce, S.A., Ankeny, M.D., Kelsey, J., 2000, *Evaluation and Management of Acid Drainage Risk from Spent Ore, El Abra Mine, Chile*, in Semi-Arid Mine Waste Issues, ICARD 2000-Proceedings from the 5th International Conference on Acid Mine Drainage.

CLIMATEDATA, 2008, *Climate data from Uravan, Montrose, and Grand Junction Colorado weather stations,* Volume 19.0, NCDC Summary of the Day-West 1, Hydrosphere Data Products, 2008

Seki, K., 2007, *SWRC Fit- A Nonlinear Fitting Program with a Water Retention Curve for Soils Having Unimodal and Bimodal Pore Structure*, Hydrology and Earth System Sciences Discussions, Vol 4.

Swanson, D.A., Savci, G., Danziger, G., Williamson, A., Barnes, C., 2000, *Unsaturated Hydrologic Assessment of Waste Rock Stockpiles in Semi-Arid Climates*, in Semi-Arid Mine Waste Issues, ICARD 2000-Proceedings from the 5th International Conference on Acid Mine Drainage.

Weir, James E.; Maxfield, E. Blair; Zimmerman; Everett A. 1983. *Regional Hydrology of the Dolores River Basin, Eastern Paradox Basin, Colorado and Utah*. USGS Water-Resources Investigations Report 83-4217.

4.0 Assumptions

- This estimate uses laboratory data for soil water characteristic curve and saturated hydraulic conductivity from a sample of development rock from the West Sunday Mine, in the Uravan Mineral District, Colorado. This data is not from a site-specific sample from the Pandora Mine, but the rock at the West Suday Mine is similar to the rock present at the Pandora Mine. Both mines exploit the Salt Wash Member of the Morrison Formation. The lithological characteristics of the rock at the West Sunday and Pandora Mines is similar, with both piles composed of medium grained sandstone from the Salt Wash Member. In addition, the methods used to construct development rock piles at the West Sunday and Pandora mines are similar. This estimate assumes that the West Sunday sample and associated laboratory data are representative of the Pandora development rock pile.

- An inherent uncertainty in this evaluation relates to the presence of cobbles and boulders in the piles, which will not fit in the laboratory capillary moisture test apparatus. However, infiltration and percolation under unsaturated conditions occurs preferentially through the fine-grained materials (Swanson et al 2000). Therefore, this assumption is considered adequate for the purposes of this estimate.

- This estimate includes development rock extending to a depth of 3 meters. Any water flux passing through the 3 meter depth is assumed to percolate to the base of the pile.

- The estimate assumes that there is no zone of saturation within the development rock piles (i.e., no groundwater is present within the pile). This assumption is supported by the fact that there are no observed springs or seeps emanating from the development rock piles.

- UNSAT-H does not simulate the effects of snow pack moisture or freezing ground conditions. This simulation assumes that effects of snow pack moisture and freezing ground conditions are negligible at the Pandora mine.

5.0 Calculations

The UNSAT-H model was chosen for this evaluation because it simulates both downward movement of water into the development rock piles during infiltration and upward movement of water from the rock piles caused by evaporation. Consideration of upward unsaturated flow is critical for accurate simulation of percolation through mine rock piles in semiarid and arid environments (Swanson et al. 2000). Numerous workers are applying rigorous unsaturated flow models based on Richard's equation for simulation of unsaturated flow through mine waste piles (e.g. Ford et al, 2000; Swanson et al., 2000, Fala et al., 2005). Benson et al. (2006) provides basic requirements for unsaturated flow models including:

- the model must simulate unsaturated flow in a rigorous manner (i.e. must solve Richards equation);

- The model must include a surface boundary simulating soil-atmosphere interactions (precipitation, infiltration, evaporation, runoff); and

- The model must integrate climatic data into the solution.

UNSAT-H meets these requirements. Although the EPA Hydrological Evaluation of Landfill Performance model (HELP) has been used in the past for these types of estimates, HELP does not meet the criterion of rigorously simulating upward movement of water through the vadose zone through application of Richard's equation. The UNSAT-H model is a fortran-based finite difference 1-dimensional model that simulates liquid water flow using Richard’s equation and water vapor diffusion using Fick’s law. UNSAT-H also is capable of simulating heat flow and plant transpiration, although these options were not applied in this estimation.

Additional details of the calculation methods and procedure applied by UNSAT-H are presented in Fayer (2000) and are not discussed further in this document. This discussion provides a summary of the modeling approach including description of model nodes and boundary conditions, description of climate data sources, and definition of soil characteristics. Detailed model input files, input data tables, and model output files are presented as attachments to this document.

The UNSAT-H model incorporated the following:

- The model simulated percolation from the base of the development rock pile at the Pandora Mine, which is located approximately 1 mile east of La Sal, Utah.

- The model used a 3 meter thick development rock profile, and included 111 nodes. The nodes are spaced very close in the upper portion of the soil profile and are more widely spaced in the deeper portion of the profile. The node spacing is included in the input file and additional information is included in the input list file. Input files and input list files are attached to this document as a compact disk.

- Hydrologic properties of development rock are based on trench sampling and laboratory analyses completed by Advanced Terra Testing in Lakewood, Colorado from the West Sunday Mine in the Uravan District, Colorado. These data are included in the attached compact disk. Capillary moisture data were fit to the van Genuchten model using the program SWCC Fit (Seki 2007). The van Genutchen-Burdine model was used for estimation of the unsaturated hydraulic conductivity. The SWCC Fit output files for the West Sunday Mine sample are included in in the attached compact disk. Vapor flow was simulated using a tortuosity of 0.66 and a vapor diffusivity of 0.27 centimeter squared per second. The average soil temperature was assumed to be 283 degrees Kelvin.

- The model simulated percolation occurring during an average precipitation year (assumed to be 1985) and the wettest year on record (1986).

- The climate data used in the model includes precipitation data from La Sal, Utah, which is located approximately 1 mile west of the Pandora Mine. Because wind speed, wind direction, temperature, and relative humidity data are not available for the La Sal site, these data were compiled from a weather station located in Blanding, Utah. Wind speed, wind direction, temperature, and relative humidity data are also available for Moab, Utah, which is closer to the Pandora Mine than Blanding. However, the Moab data were not used because Moab is located at a significantly lower elevation than La Sal. Average percent cloud cover data were compiled from Grand Junction, Colorado. Solar radiation data for the site were compiled from the National Solar Radiation Database. Other meteorological parameters included in the model include an albedo of 0.4, altitude of 2,172 meters, and average annual atmospheric pressure of 852 millibars. Climate data and solar radiation data (with appropriate unit conversions) are provided in the attached compact disk.

- A variable flux atmospheric boundary was applied at the surface and a unit gradient boundary was applied at the bottom of the 3 meter profile. Vapor pressure at the surface was computed based on the daily atmospheric humidity specified in the climate input files. The daily temporal distribution of potential evaporation was

assumed to be sinusoidal. A matric suction of 1 x 10^{-7} centimeters was used for the initial conditions at all nodes.

- The model was run using a 39 year initialization period followed by either an average precipitation year (assumed to be 1985) or the wettest year on record (1986). The initialization period is based on sequential average precipitation years to reduce the potential effect of initial conditions regarding the soil moisture at each node on the estimated percolation resulting from either the average precipitation year or the wettest year on record.

Table 1 summarizes the results of the modeling effort for the Pandora Mine. The corresponding UNSAT-H output files are included in the attached CD.

Table 1. Summary of UNSAT-H modeling results (all results in centimeters).

Model Run	Annual Potential Evap. (cm)	Annual Precipitation (cm)	Annual Actual Evap. (cm)	Annual Runoff (cm)	Annual Infiltration (cm)	Annual Percolation (cm)
Average Precipitation	1.9005E+02	3.3807E+1	3.3733E+1	0	3.3807E+1	7.1394E-03
Wettest year on Record	1.9005E+02	5.1029E+1	4.2482E+1	2.8643E0	4.8164E+1	7.4589E-03

Based on the UNSAT-H simulations, the estimated basal liquid flux is estimated to be approximately 0.007 centimeters per year. The simulations show the importance of evaluating upward movement of water from the rock piles caused by evaporation because the majority of water that infiltrates the surface of the development rock piles evaporates in the semi-arid environment present at the Sunday Mines Group.

Data regarding mass balance errors for the UNSAT-H simulations are included in the output files, which are included in the attached CD. The annual mass balance errors for the simulations summarized in Table 1 range from 5.4067E-5 to 1.4908E-4 centimeters.

A sensitivity analysis was also run in which several model inputs were varied to examine the effect of the changes in input parameters. This information is summarized in Table 2.

Table 2. Sensitivity analysis of selected input parameters.

Simulation	Precipitation (cm)	Modified Parameter	Initial Value	Modified Value	Estimated Percolation (cm)
1	33.807	Time Step Control Parameter (DMAXBA)	1.00E-3	1.00E-4	7.1395E-03
2	51.029	Time Step Control Parameter (DMAXBA)	1.00E-3	1.00E-4	7.4590E-03
3	33.807	Initial Soil Matric Potential	1.0000E+07 cm	1.0000E+03 cm	7.3745E-03
4	33.807	Initial Soil Matric Potential	1.0000E+07 cm	1.0000E+05 cm	7.2898E-03

6.0 Conclusions

The UNSAT-H simulations suggest that significant percolation from the base of the Pandora development rock pile is unlikely. However, a small amount of percolation is estimated for all simulations. The simulations further suggest that infiltration of precipitation followed by upward evaporative flux of water stored within the development rock areas are dominant mechanisms controlling the volume of percolation through the development rock areas.

The results of the UNSAT-H simulations correspond to the input parameters including the development rock physical and hydrologic parameters, and the available climate data. Site-specific climate data are not available, and differences between actual climate conditions at the site and the data compiled from the La Sal, Blanding and Grand Junction weather stations could result in variations in estimated percolation through the piles. In addition, site-specific data were not available for physical and hydrological characteristics of the Pandora rock pile, and data from a similar rock pile at the West Sunday Mine in Colorado were used. Potential variations in physical and hydrological characteristics between the modeled rock pile and the Pandora rock pile also contribute to uncertainty in the UNSAT-H simulations.